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DECEMBER 1959

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A Journal for All Science and Mathematics Teachers

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SCHOOL SCIENCE AND MATHEMATICS

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The Direct Measurement of "G"

John Noehl

4025 S.E. 32 Ave., Portland, Oregon

The usual methods for the measurement of the acceleration of a free falling body in high school physics (if done at all) do not give the student a good understanding of the concepts of motion involved. These methods (pendulum, Atwood's machine, etc.) do not present a simple clear connection between the theory and actual measurement. For example, the determination of g using a pendulum leaves something to be desired in terms of students associating this with the motion of free falling bodies. The method of measuring g described herein utilizes the motion of a free falling body.

The method consists of dropping a weighted piece of magnetic tape through the pole pieces of an electromagnet operated from the mains. The a-c in the mains provides a 1/120 second time interval which registers directly on the free falling tape. The tape is developed by placing it in a solution of carbon tetrachloride and iron filings.

The appartus* is constructed as follows: Obtain a $\frac{1}{2}$ inch bolt about 3 inches long threaded its entire length and saw off the head. Place 2 cardboard spacers on the bolt as shown in Fig. 1, wrap 2 layers of electrical tape around the bolt in the space between the cardboard spacers. Next, wrap about 1500 turns of No. 32 enameled copper wire around the bolt between the spacers, leaving about 6 inches of wire exposed on each end of the coil and apply a few layers of tape over the finished coil. Bend two right angle brackets as shown in Fig. 2 and file down the ends to form knife edges. Place the pole

* The initial suggestion for this apparatus was received from the staff members of the PSSC Institute at Reed College during the summer of 1958.

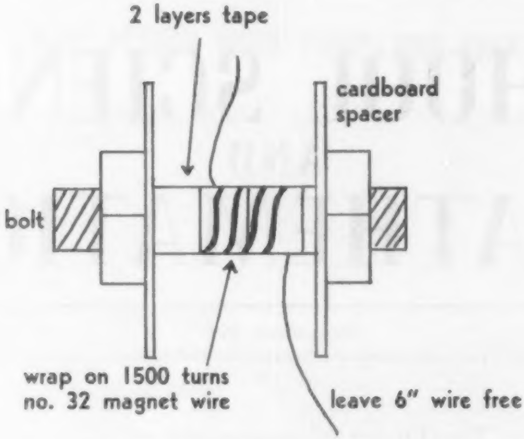


FIG. 1

pieces on the ends of the coil, mount in a wooden frame and secure with nuts (Fig. 3). Connect one of the free ends of the coil to one side of a lamp cord and the other to one side of a micro-switch (doorbell switch works well). Connect the other wire of the lamp cord to the micro-switch (Fig. 4).

The apparatus is then set up as shown in Fig. 5. A 4 inch length of $\frac{3}{8}$ inch glass tubing is mounted above the pole pieces of the electromagnet to guide the tape. Take a piece of magnetic recording tape

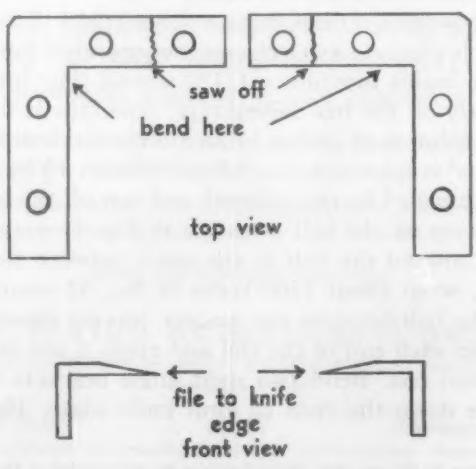


FIG. 2

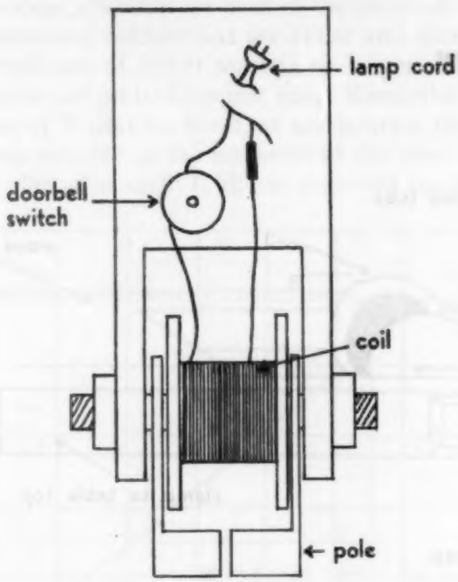


FIG. 3

about $2\frac{1}{2}$ feet long and form a loop in one end. Secure the loop with scotch tape and thread the tape through the pole pieces with the loop end down and attach a weight (50 to 500 g) to the loop. Close the micro-switch and drop the tape. Release the micro-switch.

Develop the tape by placing it in a solution of carbon tetrachloride containing fine, oil-free, iron filings or magnetic iron oxide. Shake the solution well before putting the tape into the container. An alternate method is to wrap the tape in a spiral around a small test tube, securing the ends with Scotch Tape, with emulsion (dull) side out and dip

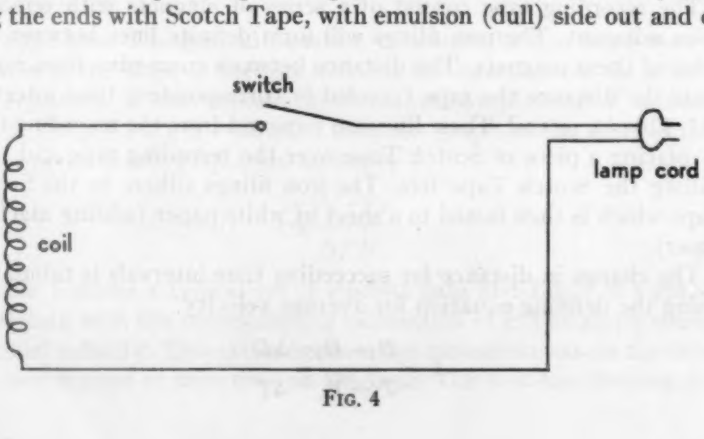


FIG. 4

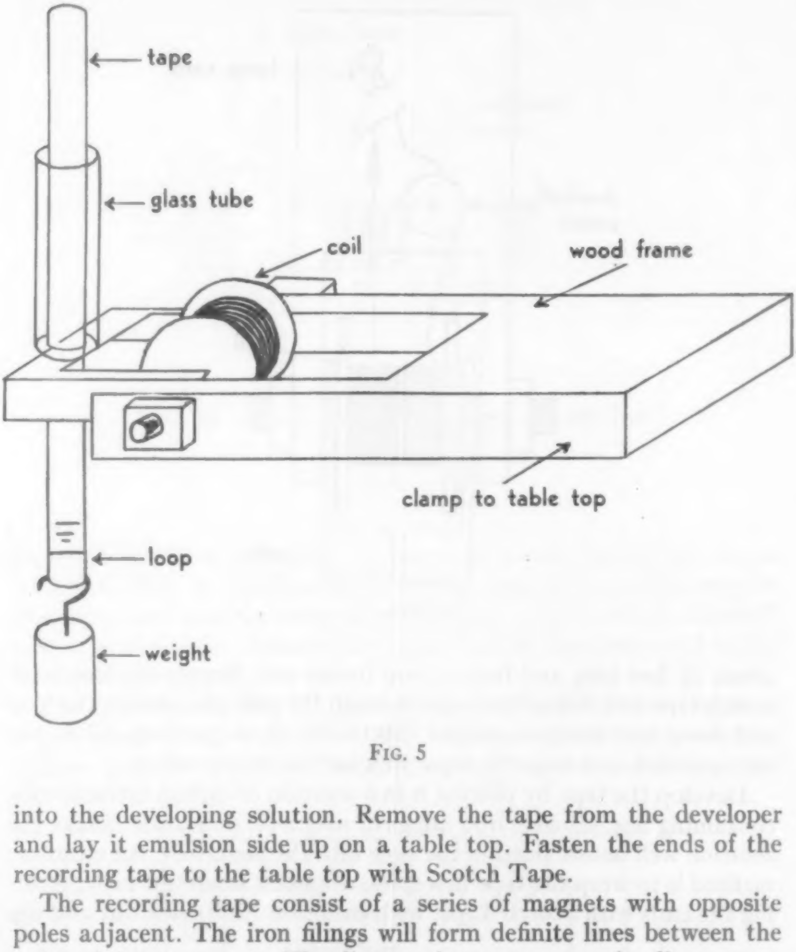


FIG. 5

into the developing solution. Remove the tape from the developer and lay it emulsion side up on a table top. Fasten the ends of the recording tape to the table top with Scotch Tape.

The recording tape consist of a series of magnets with opposite poles adjacent. The iron filings will form definite lines between the poles of these magnets. The distance between successive lines represents the distance the tape traveled in corresponding time intervals of 1/120 of a second. These lines are removed from the recording tape by placing a piece of Scotch Tape over the recording tape and then pulling the Scotch Tape free. The iron filings adhere to the Scotch Tape which is then fasted to a sheet of white paper (adding machine paper).

The change in distance for succeeding time intervals is tabulated. Using the defining equation for average velocity,

$$V=\frac{D_2-D_1}{T_2-T_1}=\frac{\Delta D}{\Delta T}$$

calculate the average velocities for each of the intervals on the tape. The measurements and calculations are easier and more significant when the intervals are of 3/120 seconds or longer. The values of average accleration are plotted against time. Remember when plotting these values of $\bar{V}$ that for constant acceleration they represent the instantaneous velocity at the midpoint of the time interval and hence would be plotted as such. If all has gone well the graph will be

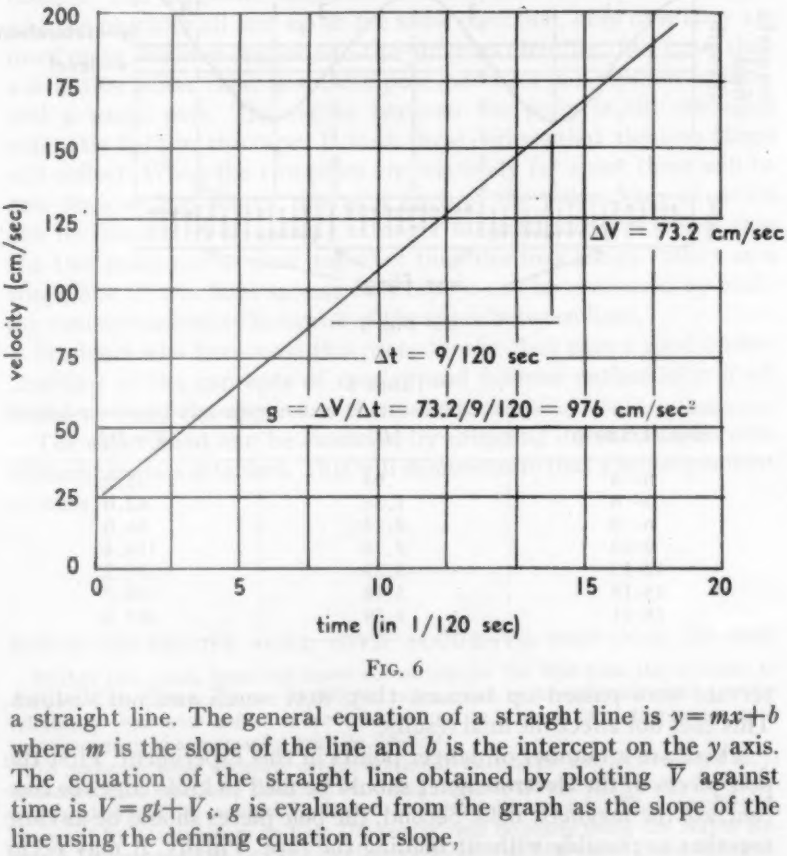


FIG. 6

a straight line. The general equation of a straight line is $y=mx+b$ where m is the slope of the line and b is the intercept on the y axis. The equation of the straight line obtained by plotting $\bar{V}$ against time is $V=gt+V_i$. g is evaluated from the graph as the slope of the line using the defining equation for slope,

$$g=\frac{V_2-V_1}{t_2-t_1}.$$

Table 1 shows a typical set of student data and Fig. 5 is a graph of the data with the corresponding calculation of g. The graph shows an initial velocity. This arises because the measurements on the tape were not started at zero time on the tape. The first few distance in-

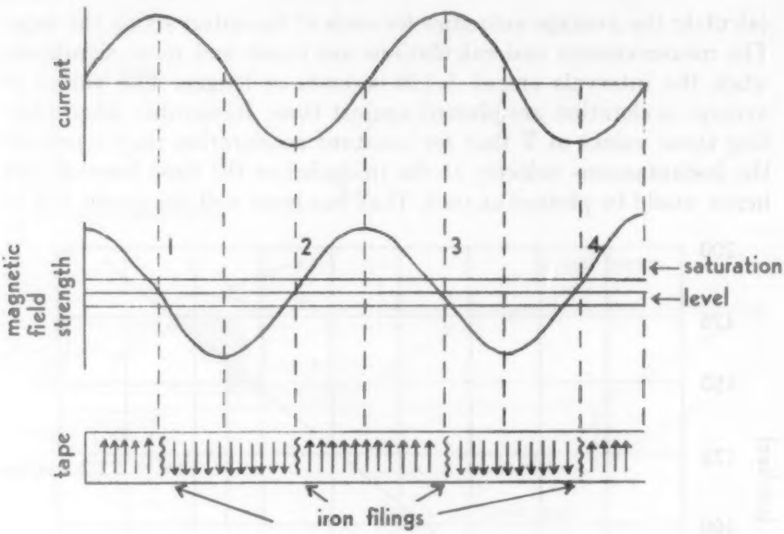


Fig. 7

Table I

time (1/120 s)	D	$V=D/t$
0– 3	.93	37.2
3– 6	1.55	62.0
6– 9	2.15	86.0
9–12	2.76	110.4
12–15	3.38	135.2
15–18	3.98	159.2
18–21	4.59	183.6

tervals were passed up because they were small and not distinct. This does not affect the final results.

There are a number of danger points in this experiment. First the pole pieces of the electromagnet should be filed to knife edges to concentrate the magnetic field. Second, the pole pieces should be as close together as possible without binding the tape. Finally, it may occur that instead of single lines on the tape two closely spaced lines appear. The probable explanation for this is as follows: The a-c current is a sine wave function and from elementary calculus the rate of change of a-c current is given by the differential of the sine function, the cosine function. The magnetic field is greatest over the regions where the current is changing most rapidly and is also a periodic function rising to a maximum and then dropping to a minimum. The

magnetic field produced by the coil is great enough so that it quickly saturates the recording tape. During the period when the magnetic field saturates the tape, all the particles in the recording tape will be lined up in the same direction. When magnetic field strength falls below the saturation level of the tape (see points 1, 2, 3, etc. in Fig. 6) every 1/120 second and during the time it is below the saturation level of the tape the particles will be distributed in a rather random fashion. The magnetic field soon reaches the saturation level again and the particles all line up in the same direction, only now they are lined up in manner opposite to the previous direction. We have then a situation where there is a north pole, particles in a random fashion, and a south pole. The region between the poles is the strongest magnetic field in the tape. It is in these regions that the iron filings will collect. When the two poles are relatively far apart there will be two lines of iron filings, one near each of the poles. This situation can be eliminated by using a stronger magnetic field in which case the two poles are so close together that the iron filings collect as a single line. If two lines appear on a tape it can be evaluated by mak ing measurements to the center of the space between lines.

Students who have used this procedure in class gain a good understanding of the concepts of motion and become enthusiastic if allowed to build the apparatus themselves.

The experiment can be extended by dropping different tapes with different masses attached. This will demonstrate that g is independent of mass.

RADIO TELESCOPE WILL GIVE ACCURATE DISTANCE TO SUN

Within two years, man will know accurately for the first time the distance to the sun. This distance, some 93,000,000 miles, must be known with much greater reliability than now before space vehicles can be sent on trips to planets with any assurance of a successful orbit or landing.

To make the most accurate determination to date of the sun's distance, a radio telescope with especially designed receiving equipment will tune in on the radio waves absorbed by neutral hydrogen in interstellar clouds. The experiment, proposed by astronomers at Yale University, will be made using the Naval Research Laboratory's 84-foot radio telescope located at Maryland Point Observatory, some 50 miles south of here.

Astronomers call the distance to the sun the astronomical unit. It establishes the basic scale of the solar system and is fundamental to space technology as well as astronomy.

The initial velocity of a rocket departing from earth must be changed from conventional units into a velocity in astronomical units per second in order to permit calculation of the gravitational orbit beyond the immediate vicinity of the earth. Thus an exact distance for the astronomical unit is not needed for lunar probes.

A Relaxation Oscillator

Eleventh in a Series

Harald C. Jensen
Lake Forest College, Lake Forest, Illinois

The previous article in this series[1] dealt with the electromotive-force induced in an inductor when its magnetic field collapses. The point of primary interest in that apparatus is the energy stored in a magnetic field and the possibility of converting it to work per unit charge or electromotive-force.

The complementary situation is that of storing energy in the electric field between the plates of a capacitor. This energy can also be used to flash a neon bulb[2] if the circuit pictured in figure one and shown in schematic form in figure two is realized. This apparatus is one form of a relaxation oscillator. When the circuit is completed, the capacitor C[3] is charged by the battery *B*. The time of charging is dependent upon the value of *C* and the series resistor *R*. At the moment that the potential difference across *C* is large enough to ignite the neon bulb *N*, the capacitor is discharged instantaneously through the bulb producing a flash of light. After the bulb is extinguished, the charging process again takes place and becomes repetitive or periodic. The frequency of the flashing depends on the time constant *RC* of the combination. If a dial decade capacitor is used this frequency can be varied over wide limits.

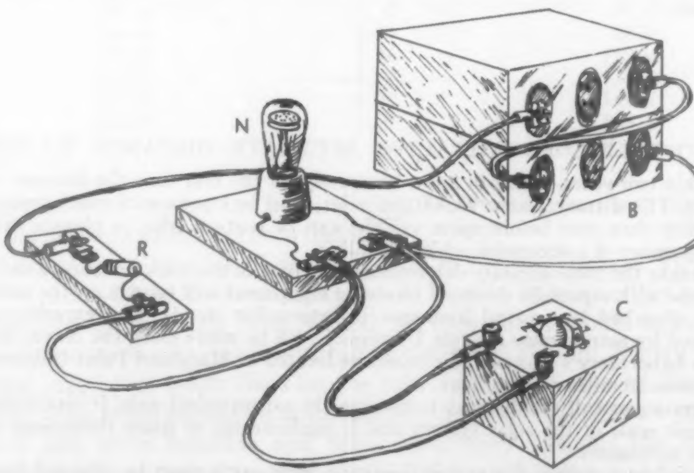


FIG. 1. Pictorial sketch of a relaxation oscillator.

[1] *Induced Emf*. H. C. Jensen, SCHOOL SCIENCE AND MATHEMATICS, LIX, 6, 489, June 1959.
[2] Like NE 34; #52E803, Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Illinois.
[3] #84F453, Allied Radio Corporation.

The battery B[4] must have a voltage higher than the ignition potential of the neon bulb. 90 volts is satisfactory for the bulb specified. A one megohm—one watt resistor[4] is an appropriate value for *R*. Note that the time constant for 1 megohm and 1 microfarad is 1 second and that the bulb should flash about once every second for such a combination.

Since so very little energy is required, no switch is used in the circuit. It may be left operating for very long periods of time without running down the battery. This feature of the apparatus makes it a very desirable one for exhibit purposes where the student can use the variable capacitor to change the frequency of flashing.

The quantitative aspect can also be utilized. The time constant, *RC* seconds, is a close approximation to the period of flashing.

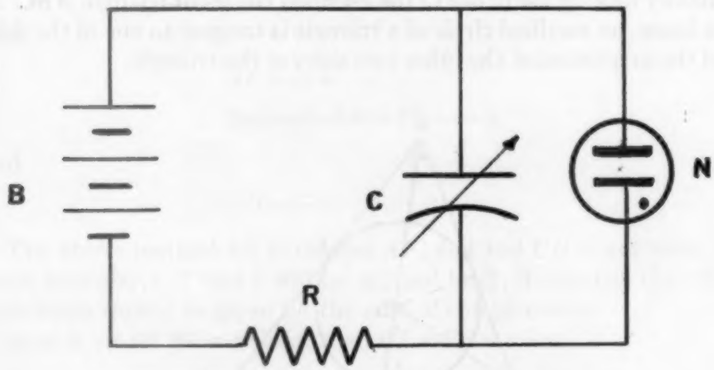


FIG. 2. Schematic diagram of a relaxation oscillator.

[4] Can be secured from suppliers of electronic or radio apparatus.

NEW METHOD DETECTS SILENT SATELLITES

A new method for detecting satellites whose radio transmitters are no longer operating is now available. It was devised by three "ham" radio operators.

They found that each satellite builds and carries along with it a cloud of ionized particles, and that this cloud can be detected by listening to disturbances it causes in the radio transmission of WWV. WWV is the National Bureau of Standards' broadcast station carrying standard time signals at various frequencies.

Two very different types of disturbances at a frequency of 10 megacycles were found. Another effect was found at the 20 megacycle frequency, a fast flutter, similar to the familiar airplane flutter seen on TV screens.

The scientists have dubbed the two effects at 10 megacycles, "Doppler" and "Rumble." Both are audible radio tones.

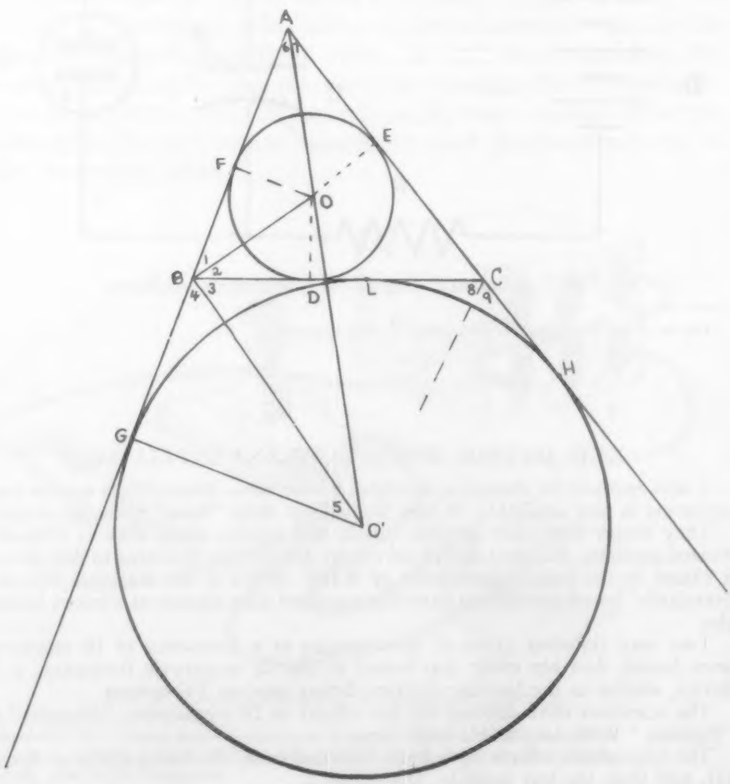
The ionospheric effects have been recorded from the two sections of Sputnik III, and from the lost satellite, Discoverer I.

A Geometric Proof of Half Angle Formulas for Triangle ABC by Means of an Escribed Circle

Benjamin Greenberg
Fort Hamilton High School, Brooklyn, N. Y.

Formulas for the half angles of a triangle in terms of the sides of the triangle are derived in all satisfactory trigonometry textbooks. As far as I have been able to ascertain all the proofs are derived with little recourse to plane geometry. The usual proofs involve the law of cosines and a formula for the radius of the inscribed circle in terms of the sides of the triangle.

The following article will show proofs of the same half angle formulas by making use of one of the escribed circles of triangle ABC. As you know, an escribed circle of a triangle is tangent to one of the sides and the extensions of the other two sides of the triangle.



The diagram shows circle O, the inscribed circle of triangle ABC, and it also shows circle O' an escribed circle of triangle ABC. The construction of the circles makes $\measuredangle 6=\measuredangle 7$, $\measuredangle 1=\measuredangle 2$, $\measuredangle 3=\measuredangle 4$ and $\measuredangle 8=\measuredangle 9$. Note that OE, OF and OD are radii of the inscribed circle O, and that $O'G$, $O'L$ and $O'H$ are radii of the escribed circle O' of triangle ABC.

As usual we denote $a+b+c$ by $2s$. Notice also that $AF=AE$, $BF=BD$, $CE=CD$.

$$AF+AE+BF+BD+CE+CD=a+b+c=2s$$

$$2\overline{AF}+2\overline{BD}+2\overline{CD}=2s$$

so that

$$AF+BC=s$$

and

1) $AF=s-a$

2) Similarly $BD=BF=s-b$

and

3) $CD=s-c$

The above method for obtaining AF, BD and CD is not new, but since formulas 1, 2 and 3 will be utilized later, it was felt that their derivation should be given for the sake of completeness.

Now if we let $BL=BG=x$, then $CL=CH=a-x$;

$$AG=AB+BG=AB+BL=c+x,$$

$$AH=AC+CH=AC+CL=b+a-x.$$

Since $AG=AH$ we have that $c+x=b+a-x$ and

4) $x=BG=BL=\dfrac{a+b-c}{2}=s-c$

5) Now $AG=AH=\frac{1}{2}(AG+AH)=\frac{1}{2}(a+b+c)=s.$

In triangle AFO,

$$\text{tangent } \tfrac{1}{2}A=\frac{OF}{AF}$$

In triangle AGO',

$$\text{tangent } \tfrac{1}{2}A=\frac{O'G}{AG}\cdot$$

Therefore,

6) $$\text{tangent}^2 \tfrac{1}{2}A = \frac{O'G}{AG} \cdot \frac{OF}{AF}$$

$\measuredangle 1 = \measuredangle 2$

$\measuredangle 4 = \measuredangle 3$

$\measuredangle 2 + \measuredangle 3 = 90°$ so that $\measuredangle 1 + \measuredangle 4 = 90°$

$\measuredangle 5 + \measuredangle 4 = 90°$ so that $\measuredangle 5 = \measuredangle 1$.

We now have that right triangle OFB is similar to right triangle $O'BG$. This gives

7) $$O'G \cdot OF = BF \cdot BG.$$

Substituting 7 in 6 we obtain

$$\text{tangent}^2 \tfrac{1}{2}A = \frac{BF}{AG} \cdot \frac{BG}{AF} = \frac{(s-b)(s-c)}{s(s-a)} \text{ (From 2, 4, 5, 1.)}$$

Consider now triangles AOB and $AO'C$.

$$\measuredangle BOO' = \measuredangle 1 + \measuredangle 6 = \tfrac{1}{2}(A+B)$$

$$\measuredangle O'CH = \tfrac{1}{2}\measuredangle BCH = \tfrac{1}{2}(A+B).$$

Therefore,

$$\measuredangle AOB = 180 - \measuredangle BOO' = 180 - \measuredangle O'CH = \measuredangle ACO'.$$

We also have that $\measuredangle 6 = \measuredangle 7$. This makes triangle $AO'C$ similar to triangle AOB. This gives

8) $$AO' \cdot AO = AC' \cdot AB.$$

$$\text{Cosine } \tfrac{1}{2}A = \frac{AF}{AO} \text{ in right tirangle } AFO,$$

$$\text{Cosine } \tfrac{1}{2}A = \frac{AG}{AO'} \text{ in right triangle } AGO'.$$

Therefore

$$\text{cosine}^2 \tfrac{1}{2}A = \frac{AG}{AO'} \cdot \frac{AF}{AO} = \frac{AG}{AB} \cdot \frac{AF}{AC} \text{ (From 8.)}$$

So that

$$\text{cosine}^2 \tfrac{1}{2}A = \frac{s(s-a)}{bc} \text{ (From 1 and 5.)}$$

Finally

$$\text{sine } \tfrac{1}{2}A = \frac{OF}{AO} \text{ in right triangle } AFO.$$

Also

$$\text{sine } \tfrac{1}{2}A = \frac{GO'}{AO'} \text{ in right triangle } AGO'.$$

Therefore

$$\text{sine}^2 \tfrac{1}{2}A = \frac{OF}{AO}\cdot\frac{GO'}{AO'} = \frac{BF}{AC}\cdot\frac{BG}{AB} \text{ (From 1 and 8.)}$$

$$\text{sine}^2 \tfrac{1}{2}A = \frac{(s-b)(s-c)}{bc} \text{ (From 2 and 4.)}$$

Plates as Tops

John Satterly
University of Toronto, Toronto, Canada

Many University professors now wash up and wipe the dishes. While doing this I have observed an interesting phenomenon. After the usual washing and wiping of some plates of about six inches in diameter I have been in the habit of throwing them onto the table with a clockwise motion. This motion gradually dies down and is succeeded by an anticlockwise motion. Why is this? If the plate is thrown flat on the table there is no final anticlock motion; the plate must be inclined to the horizontal and the greater this inclination the greater and more lasting is the reverse motion. My plates have a discrete pattern on their edges, which renders the motion easily visible.

As all know an ordinary peg top precesses in the same direction as its main rotation. As this main rotation gradually falls off a time will come when the body of the top touches the table and at this moment the reverse rotation starts. It seems that at this first contact the top receives such a frictional impulse from the floor to cause the reversal.

The same phenomenon may be obtained with the gear wheels of dismantled clocks when spun on their spindles.

The "Tippe-top" also when it turns upside down reverses its rotation. The same explanation holds; for more details on this top see A. R. Del Campo[1] and I. M. Freeman[2]

[1] *Am. J. Phys.*, 23: 544, 1955.
[2] *Am. J. Phys.*, 24: 178, 1956.

The Window of the World

Harold P. Pluimer
Dept. of Education, St. Paul, Minnesota

The 1958 Brussels International Exhibition was a truly tremendous and ingenious display of human endeavor. Seeing all this, sometimes called the Window of the World, although it seemed to be slightly tinted, was indeed all inspiring. Even a casual visitor could not help but be deeply impressed, and in some instances deeply concerned.

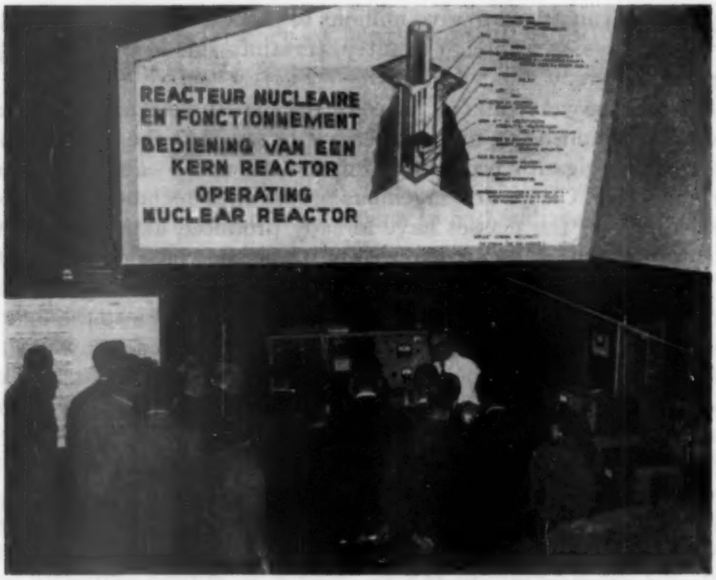
More than 50 countries erected pavilions and exhibits. The host nation, Belgium, had about 30 pavilions and exhibits. There were 11 itinerary tours planned with each having about 25 pavilions which indicated the magnitude and scope of the project.

The Atomium, towering over the center of the fair, represented an elementary crystal of iron enlarged 150 billion times. The construction was about 470 feet high. The nine spheres formed a centered cube, resting on one of its angles. The spheres were linked by tubes 10 feet in diameter and almost 100 feet in length. The spheres contained large air conditioned halls and at might luminous points traveled around the spheres to depict the movement of electrons around the nucleus of the atom. The sight was particularly impressive during the evening.

The International Hall of Science was fabulous. In all, 15 countries participated in varying degrees with both the United States and Russia as major contributors. The contributions emphasized progress made in the studies of four specific categories of research. These were: The Atom, The Molecule, The Crystal, and the Living Cell. One of the most popular single exhibits in the Hall of Science was our operating nuclear reactor. A series of lecture-demonstrations by Dr. Hubert Alyea, of Princeton University (oftentimes called the Dean of Demonstrators), left a deep and warm impact on the thousands of visitors at the lecture hall.

It was quite evident, from the exhibits in the various pavilions, that education is rapidly becoming the most vital force in the world. This was nowhere more apparent than in the USSR pavilion and her satellite pavilions. Their educational efforts are geared to science and scientific research to produce the necessary brainpower to exploit the aims of the state.

Inside the Russian pavilion one sensed a strange feeling. It was difficult to escape that cloak of compulsion that crept over you once inside the massive hall. The main floor was given up to huge machines, large exhibits of automation working silently, and in the very center a huge Sputnik suspended. The descriptive leaflets of her satellite program, distributed by the millions, read "Congratulations moon—



you have a new baby brother." Anywhere in the pavilion one could see the towering replica of Lenin and the hammer and sickle. The atmosphere was about as cold as the steel that was displayed. Strength, labor, sweat, and physical feats were glamorizd to extremes. It was reported by Dr. Hubert Alyea, that the Russians employed a massive woman to unload their heavy machinery and equipment. This amazed the Belgian workers as it took from 5 to 6 men to duplicate her efforts. This all seems to be a very peculiar way of gaining recognition, but nontheless very effective, especially in Europe.

With the American pavilion it was quite different, even though there was considerable criticism, mostly from the American Tourists. At least we have that privilege, although much of it was unwarranted. We were decidedly lacking in a secondary school education exhibit, although we did display a football uniform. The atomic energy exhibit was fair, depicting the birth, life, and death of an isotope. The models wearing the latest American clothes were always popular and drew heavy applause. The voting machines, NBC Color TV, and the American Theater were also a hit with the visitors. The American guides were tremendous and certainly did justice to our exhibit and our way of life. Probably our most impressive entry was Walt Disney's Circarama, a 360 degree screen picture taking the viewer on a panoramic tour of the United States. One news editor in Brussels summed up our efforts concluding with "Who are they, this

people that can afford to give millions to plant a few kilos of beauty, for a few days, in a foreign country, certainly this is a big nation, a big lesson."

It would be very difficult to compare the Russian and American efforts. It would be an understatement to say that the Russians are engaged in a gigantic program to impress the world—and it has been very effective. Clever and ingenious propaganda techniques directed particularly at the masses have already produced alarming results. For example the Moscow Circus won thousands of converts during its stay in Brussels. As the concluding act about 40 magnificently trained doves of peace circled the audience and "flew into the light." The ovation was tremendous and the writer walked away with a heavy heart. Recently the Soviet Union has announced that Russian scientific apparatus and equipment is available for sale in the United States at costs below that of American suppliers.

Seeing all this it becomes clear that our work as educators is clearly cut out for us. We must pursue our teaching efforts with vigor and a sense of urgency second to none. We certainly cannot afford the comfort of complacency.

Participating in this tremendous and powerful exposition was an experience of no mean proportions but a recapulation of the scene through the Window of the World revealed much more, for farther and deeper than the magnificent "Pantheon's" loomed the humanities and the sciences, not science as a fearful alchemy exercised by the gods like the Soviet portrayal, but science and understanding for the mutual benefit of all nations and peoples. And even farther, in the dim background, almost obscured, appears the untiring work of the teacher, whose positive direction and efforts have merged meaning and appreciation into the mighty works of our Creator.

TURBOJET-RAMJET COMBINED TO MAKE EFFICIENT PLANE

A combined turbojet and ramjet engine has been invented. It should power an aircraft that is highly efficient both at sub- and supersonic speeds.

Because a ramjet needs the speed of the aircraft to compress the air it is inefficient at low speeds and cannot start the airplane from a standstill. At high speeds, however, the ramjet is highly efficient.

The turbojet complements the properties of the ramjet. It is efficient at low speeds and can be used for take-off. When its efficiency begins to decrease at high speeds the ramjet's efficiency starts to rise above it.

Both engines use the same air intake duct, and exhaust pipe. Valves simultaneously close the entrance to the turbojet and open the duct to the ramjet.

Articles on the History of Mathematics: A Bibliography of Articles Appearing in Six Periodicals

Cecil B. Read
University of Wichita, Wichita, Kansas

Although there are several excellent books dealing with the history of mathematics there is often occasion to find additional material on some particular topic. Some of the magazines containing such material are not listed in the customary library indices, hence it is not always easy to locate information. A large majority of articles dealing with the history of mathematics appears in six periodicals; it is the purpose of this publication to present a bibliography of such articles which have appeared in these specified periodicals. It is hoped that the bibliography is complete to July 1, 1959, but no doubt there are omissions.

It has been somewhat difficult to determine whether or not certain articles should be included. Articles which are entirely a bibliography were usually excluded. In general if the article deals primarily with the historical aspects of a topic, it was included; if, on the other hand, the historical content is a minor portion, the article was not included. The decision is, of course, somewhat arbitrary, and in some cases seems to have been violated. This is true where, although the historical portion is relatively small, facts are brought out which seem unavailable in other references. A question might be raised as to the value of listing a large number of brief biographies of individuals who seem to have little effect upon the history of mathematics. However, any one who has tried to locate material concerning one of these relatively obscure mathematicians will no doubt appreciate the listing of even a brief article.

It is hoped that this publication will serve more than one purpose: not only will it supplement material found in books on the history of mathematics and in general reference works, but it should also furnish valuable material for the teacher of mathematics at the elementary, secondary, or college level. Some of the material furnishes valuable suggestions for mathematics club programs. The bibliography will probably find its greatest use as a reference list of enrichment material. Most of the articles are readable by students and many could easily be presented to their classmates.

The division of the material into major categories was made with the idea that this might increase the value of the bibliography. As with any classification scheme, the assigning of an article to a certain category is sometimes difficult. If an article deals with the work of a mathematician as a whole, or with mathematics in a particular period

or locality, it has been so classified, but if it deals with a particular topic, as contrasted to the entire work of a mathematician or of a period or locality, it has been placed in the section corresponding to that topic. For example, an article entitled "Did the Arabs Know the Abacus?" is classified under *Calculating Methods and Devices*, rather than *Mathematics in Other Countries*. In like manner, an article headed "Gauss and the Regular Polygon of Seventeen Sides" would be classified under *Geometry and Geometrical Problems*, rather than *Mathematicians of the 19th and 20th Centuries*. No doubt in several cases a dual listing would have been helpful, but considerations of space seemed to prohibit this.

For brevity, references have been given only by the volume number and pages, making use of certain obvious abbreviations:

AMM—The American Mathematical Monthly
MG—The Mathematical Gazette (New Series)
MT—The Mathematics Teacher
NMM—National Mathematics Magazine. (Volumes 1–8 were published as Mathematics News Letter; starting with Volume 21, this has been published as Mathematics Magazine. The single abbreviation NMM is used in all cases.)
Scripta—Scripta Mathematica
SSM—School Science and Mathematics

The History of Mathematics as a Whole

Archibald, R. C., Outline of the history of mathematics. AMM 56: supplement.
Bass, W. S., The historical argument for teaching arithmetic, geometry, and algebra together in the first year of high school. SSM 5: 712–716.
Burgess, Jr., E. G., Mathematics. SSM 24: 264–272.
Court, N. A., Mathematics in the history of civilization. MT 41: 104–111.
Curtiss, D. R., Fashions in mathematics. AMM 44: 559–566.
Fehr, H. F., Breakthroughs in mathematical thought. MT 52: 15–19.
Jones, P. S., The history of mathematics as a teaching tool. MT 50: 59–64.
Karpinski, L. C., The parallel development of mathematical ideas, numerically and geometrically. SSM 20: 821–828.
Kinsella, J. and Bradley, A. D., The one world of mathematics. MT 40: 355–358.
Mayer, J., Mathematical ideas. SSM 55: 5–13.
Miller, G. A., Correcting errors in the histories of mathematics. SSM 35: 977–983
Miller, G. A., A few uncertainties in the history of elementary mathematics. SSM 32: 838–844.
Miller, G. A., A first lesson in the history of mathematics. NMM 13: 272–277.
Miller, G. A., A second lesson in the history of mathematics. NMM 14: 144–152.
Miller, G. A., A third lesson in the history of mathematics. NMM 15: 234–244.
Miller, G. A., A fourth lesson in the history of mathematics. NMM 17: 13–20.
Miller, G. A., A fifth lesson in the history of mathematics. NMM 17: 212–220.
Miller, G. A., A sixth lesson in the history of mathematics. NMM 17: 341–350.
Miller, G. A., A seventh lesson in the history of mathematics. NMM 18: 67–76.
Miller, G. A., An eighth lesson in the history of mathematics. NMM 18: 261–270.
Miller, G. A., A ninth lesson in the history of mathematics. NMM 19: 64–72.
Miller, G. A., A tenth lesson in the history of mathematics. NMM 19: 286–293.
Miller, G. A., An eleventh lesson in the history of mathematics. NMM 21: 48–55.
Miller, G. A., Histories of mathematics by Florian Cajori and D. E. Smith. SSM 24: 939–947.

Miller, G. A., History of mathematics. AMM 22: 299–304.
Miller, G. A., Marginal notes on Cajori's *History of Mathematics*. SSM 19: 830–835; 20: 300–304; 23: 138–149.
Miller, G. A., Mathematical myths. NMM 12: 389–392.
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Miller, G. A., On Ball's *History of Mathematics*. AMM 9: 280–283.
Miller, G. A., Primary facts of the history of mathematics. MT 32: 209–211.
Neugebauer, O., The history of mathematics. NMM 11: 17–23.
Schaaf, W. L., Mathematics and world history. MT 23: 496–503.
Servaty, I., Some points in the history of Greek mathematics which are useful in secondary teaching. SSM 5: 553–557.
Slessenger, W. W. O. and Curtis, A. R., A very short history of mathematics. MG 34: 82–83.
Wren, F. L., Curiosity and culture. MT 50: 361–371.

Mathematics in the Ancient World

Archibald, R. C., Babylonian mathematics with special reference to recent discoveries. MT 29: 209–219.
Berriman, A. E., The Babylonian quadratic equation. MG 40: 185–192.
Bruce, R. E., Sicily and the march of ancient mathematics and science to the modern world. Scripta 5: 117–121; 181–185; 245–250.
Bruins, E. M., Pythagorean triads in Babylonian mathematics. MG 41: 25–28; 42: 212–213.
Cordrey, W. A., Ancient mathematics and the development of primitive culture. MT 32: 51–60.
Dehn, M., Mathematics, 600 B.C.–400 B.C. AMM 50: 357–360.
Dehn, M., Mathematics, 400 B.C.–300 B.C. AMM 50: 411–414.
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Edwards, W. M., The origin of mathematics in Greek culture. MG 15: 449–460.
Evans, G. W., The Greek idea of proportion. AMM 34: 354–357.
Evans, G. W., A riddle from Archimedes. MT 20: 243–252.
Evans, G. W., Some of Euclid's algebra. MT 20: 127–141.
Fields, M., Practical mathematics of Roman times. MT 26: 77–84.
Gillings, R. J., The oriental influence on Greek mathematics. MG 39: 187–190.
Heath, T. L., Greek geometry with special reference to infinitesimals. MG 11: 248–259.
Heath, T. L., Greek mathematics and astronomy. Scripta 5: 215–222.
Heath, T. L., Greek mathematics and science. MG 10: 289–301.
Heath, T. L., Greek mathematics and science. MG 32: 120–133.
Jones, P. S., Irrationals or incommensurables I: their discovery, and a "logical scandal." MT 49: 123–127.
Jones, P. S., Irrationals or incommensurables II: the irrationality of $\sqrt{2}$ and approximations to it. MT 49: 187–191.
Jones, P. S., Irrationals or incommensurables III—the Greek solution. MT 49: 282–285.
Jones, P. S., Recent discoveries in Babylonian mathematics, I: zero, pi, and polygons. MT 50: 162–165.
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Karpinski, L. C., Apropos of Egyptian mathematics. AMM 32: 41.
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Langer, R. E., Alexandria, shrine of mathematics. AMM 48: 109–125.

Miller, G. A., A few theorems relating to the Rhind mathematical papyrus. AMM 38: 194–197.
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Neugebauer, O., Babylonian mathematics. Scripta 2: 312–315.
Neugebauer, O., On the "Hippopede" of Eudoxus. Scripta 19: 225–229.
Nichols, I. C., The Egyptians as pure mathematicians. NMM 3: 10–13 (April, 1929).
Seidenberg, A., Peg and cord in ancient Greek geometry. Scripta 24: 107–122.
Shaw, A. A., On measures and weights by Epiphanius. NMM 11: 3–7.
Smith, D. E., Possible boundaries in the early history of mathematics. AMM 45: 511–515.
Steele, D. A., A mathematical reappraisal of the Corpus Platonicum. Scripta 17: 173–189.
Vedova, G. C., Notes on Theon of Smyrna. AMM 58: 675–683.

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Aiyar, S. B., The Ganita-Sara-Sangraha of Mahaviracarya. MT 47: 528–533.
Anonymous, The inauguration of the Institute Henri Poincare in Paris. AMM 36: 162–164.
Anonymous (W. J. G.), Japanese mathematics. MG 3: 268–270.
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Bompiani, E., Italian contributions to modern mathematics. AMM 38: 83–95.
Bushell, W. F., A century of school mathematics. MG 31: 69–89.
Cairns, W. D., Advanced preparatory mathematics in England, France, and Italy. AMM 42: 17–34.
Cheng, D. C., On the mathematical significance of the Chinese Ho T'u and Lo Shu. AMM 32: 499–504.
Courant, R., Mathematical education in Germany before 1933. AMM 45: 601–607.
Dunnington, B. W., B. F. Thibaut (1775–1832), early master of the art of teaching and popularizing mathematics. NMM 11: 318–323.
Forsyth, A. R., Old tripos days at Cambridge. MG 19: 162–179.
Gnedenko, B. V., Mathematical education in the U.S.S.R. AMM 64: 389–408.
Goldsmith, N. A., The Englishman's mathematics as seen in general periodicals in the 18th century. MT 46: 253–259.
Hasse, H. R., My fifty years of mathematics. MG 35: 153–164.
Hiyama, S., Japanese problems. MT 16: 359–365.
Jelitai, J., The history of mathematics in Hungary before 1830. NMM 12: 125–130.
Karpinski, L. C., Mathematics in Latin America. Scripta 13: 59–63.
Karpinski, L. C., The mathematics of the Orient. SSM 34: 467–472.
Kokomoor, F. W., The status of mathematics in India and Arabia during the "Dark Ages" of Europe. MT 29: 224–231.
Loria, G., The achievements of Great Britain in the realm of mathematics. MG 7: 421–427; 8: 12–19.
Mikami, Y., Mamoru Mimori, a master teacher of mathematics in Japan. Scripta 1: 254–255.
Mikami, Y., The teaching of mathematics in Japan. AMM 18: 123–134.
Miller, G. A., Mathematics in Portugal. AMM 17: 231–233.
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Pearson, K., Old tripos days at Cambridge, as seen from another viewpoint. MG 20: 27–36.
Rado, T., On mathematical life in Hungary. AMM 39: 85–90.
Robson, A., How they learnt, 1600–1850. MG 33: 81–93.
Siddons, A. W., Fifty years of change. MG 40: 161–169.

Siddons, A. W., Progress. MG 20: 7–26.
Sleight, E. R., Development of mathematics in Scotland, 1669–1746. NMM 19: 173–185.
Sleight, E. R., Mathematics in Scotland before the 18th century. NMM 18: 305–314.
Vetter, Q., Czech science during the war. Scripta 12: 141–146.
Vetter, Q., The development of mathematics in Bohemia. AMM 30: 47–58.
Watson, E. C., College life at Cambridge in the days of Stokes, Cayley, Adams, and Kelvin. Scripta 6: 101–106.
Wren, F. L. and Rossman, R., Mathematics used by American Indians north of Mexico. SSM 33: 363–372.
Wilson, J. M., The early history of the Association. MG 10: 239–247.
Wirszup, I., The Seventh Mathematical Olympiad for secondary school students in Poland. MT 51: 585–589.

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Austin, C. M., Historical account of origin and growth of the National Council of Teachers of Mathematics. MT 21: 204–213.
Bradley, A. D., The mathematical notebooks of James Boone, Jr. Scripta 6: 219–227.
Coolidge, J. L., Three hundred years of mathematics at Harvard. AMM 50: 347–356.
Feldmann, R. W., Benjamin Franklin and mathematics. MT 52: 125–127.
Jones, P. S., American mathematics. MT 49: 30–33.
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Meserve, H. G., Mathematics one hundred years ago. MT 21: 336–345.
Miller, G. A., History of mathematics in America. SSM 35: 292–296.
Phalen, H. R., The first professorship of mathematics in the colonies. AMM 53: 579–582.
Richeson, A. W., Warren Colburn and his influence on arithmetic in the United States. NMM 10: 73–79.
Simons, L. G., Algebra at Harvard College in 1730. AMM 32: 63–70.
Simons, L. G., Eighteenth century algebra in America. Scripta 3: 355–356.
Slaught, H. E., Retrospect and prospect for mathematics in America. AMM 27: 443–451.
Slaught, H. E., The teaching of mathematics in summer session of universities and normal schools. AMM 18: 147–157.
Smith, D. D., Developments in secondary mathematics. NMM 5: 4–8 (December, 1930).
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Wren, F. L. and McDonough, H. B., Development of mathematics in secondary schools of the United States. MT 27: 117–127; 190–198; 215–224; 281–295.

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Archibald, R. C., The binary scale of notation, a Russian peasant method of multiplication, the game of Nim, and Cardan's rings. AMM 25: 139–142.
Beard, R. H., The twelve base. MT 48: 332–333.
Boyer, C. B., Note on Egyptian numeration. MT 52: 127–129.
Boyer, C. B., Zero: the symbol, the concept, the number. NMM 18: 323–330.
Cajori, F., Fanciful hypotheses on the origin of the numeral forms. MT 18: 129–133.
Cajori, F., On the Chinese origin of the symbol for zero. AMM 10: 35.
Cajori, F., Sexagesimal fractions among the Babylonians. AMM 29: 8–10.
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Conant, L. L., The beginnings of counting. SSM 5: 385–394.
Datta, B., Early literary evidence of the use of zero in India. AMM 33: 449–454; 38: 566–572.

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DeMilt, C., The origins of our numeral notation. SSM 47: 701–708.
Eells, W. C., Number systems of the North American Indians. AMM 20: 263–272; 293–299.
Forno, D. M., Note on the origin and use of decimals. NMM 3: 5–8 (April, 1929).
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Ganguli, S., The Indian origin of the modern place value arithmetical notation. AMM 39: 251–256; 389–393; 40: 25–31; 154–157.
Ginsburg, J., On the early history of the decimal point. AMM 35: 347–349.
Ginsburg, J., Predecessors of Magini. Scripta 1: 168–169.
Goodstein, R. L., The Arabic numerals, numbers and the definition of counting. MG 40: 114–129.
Halsted, G. B., Our symbol for zero. AMM 10: 89–90.
Harris, R. A., Numerals for simplifying addition. AMM 12: 64–67.
Householder, A. S., An etymological excursion. AMM 44: 463–464.
Irani, R. A. K., A sexagesimal multiplication table in the Arabic alphabetical system. Scripta 18: 92–93.
Jones, P. S., Big numbers—an answered letter. MT 45: 528–530.
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Jones, P. S., "Large" Roman numerals. MT 47: 194–195.
Karpinski, L. C., Number. AMM 18: 97–102.
Langley, E. M., Mixture of "Arabic" with "Roman" numerals during the time of transition. MG 12: 468–469.
Larney, B. M., How the middle ages counted. SSM 31: 919–930.
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Miller, G. A., A crusade against the use of negative numbers. SSM 33: 959–964.
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Miller, G. A., On the history of common fractions. SSM 31: 138–145.
Richeson, A. W., The number system of the Mayas. AMM 40: 542–546.
Salyers, G. D., The number system of the Mayas. NMM 28: 44–48.
Sanford, V., The decimal point. MT 45: 71, 73.
Sanford, V., *La Disme* of Simon Stevin—the first book on decimals. MT 14: 321–333.
Sanford, V., Roman numerals. MT 24: 22–27.
Sanford, V., Roman numerals. MT 44: 403–404.
Shaw, A. A., Note on Roman numerals. NMM 13: 127–128.
Shaw, A. A., An overlooked numeral system of antiquity. NMM 13: 368–372.
Sherman, C. P., The origin of our numerals. MT 16: 398–401.
Slaught, H. E., Romance of mathematics. MT 20: 303–309.
Smith, D. E. and Mourad, S., The dust numerals among the ancient Arabs. AMM 34: 258–260.
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Woodruff, C. E., The evolution of modern numerals from ancient tally marks. AMM 16: 125–133.

Calculating Methods and Devices

Adler, J., So you think you can count! NMM 28: 83–86.
Barbour, J. M., A geometrical approximation to the roots of numbers. AMM 64: 1–9.
Bromwich, J. T. I., The methods used by Archimedes for approximating to square roots. MG 14: 253–257.
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Cajori, F., Notes on the history of the slide rule. AMM 15: 1–5.
Cheng, D. C., The use of computing rods in China. AMM 32: 492–499.

Dagobert, E. B., Analysis of an ancient method of computation. MT 48: 556–559.
Datta, B., The science of calculation by the board. AMM 35: 520–529.
Gandz, S., Did the Arabs know the abacus? AMM 34: 308–316.
Hirsch, M., An example of the method of *duplation*. MT 44: 591.
Iyer, R. V., The Hindu abacus. Scripta 20: 58–63.
Jones, P. S., The oldest American slide rule. MT 46: 501–503.
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Leavens, D. H., The Chinese Suanp'an. AMM 27: 180–183.
Lehmer, D. H., A photo-electric number sieve. AMM 40: 401–406.
Locke, L. L., The ancient Peruvian abacus. Scripta 1: 37–43.
Locke, L. L., The contributions of Leibniz to the art of mechanical calculation. Scripta 1: 315–321.
Locke, L. L., The history of modern calculating machines, an American contribution. AMM 31: 422–429.
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Miller, G. A., Inverting the denominator of a fraction. SSM 30: 881–883.
Nordgaard, M. A., The origin and development of our present method of extracting square and cube roots of numbers. MT 17: 223–238.
Phalen, H. R., Hugh Jones and octave computation. AMM 56: 461–465.
Pinette, L., Tangible arithmetic III: The proportional dividers. MT 48: 91–95.
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Ransom, W. R., An old time computer. NMM 27: 205–207.
Richardson, L. J., Digital reckoning among the ancients. AMM 23: 7–13.
Sanford, V., The art of reckoning. MT 43: 292–294.
Sanford, V., The art of reckoning III. What you can do if you know the doubles. MT 44: 29–30.
Sanford, V., The art of reckoning IV. Algorisms: Computing with Hindu-Arabic numerals. MT 44: 135–137.
Sanford, V., The Computus. MT 45: 198, 204.
Sanford, V., Counters: Computing if you can count to five. MT 43: 368–370.
Sanford, V., The rule of false position. MT 44: 307–310.
Sanford, V., The rule of signs in multiplication. MT 44: 256–258.
Simons, L. G., An early 18th century American ready-reckoner. Scripta 3: 94–96.
Simons, L. G., Historical notes on arithmetical division. Scripta 1: 362–363.
Simons, L. G., Note on an abacus. Scripta 4: 94.
Simons, L. G., A note on the chain rule. Scripta 3: 93–94.
Simons, L. G., Two reckoning tables. Scripta 1: 305–308.
Sleight, N., Pertinent historical material for a slide rule course. NMM 20: 11–20.
Vanhee, L., Napier's rods in China. AMM 33: 326–328.
Wood, F., Tangible arithmetic II: The sector compasses. MT 47: 535–542.
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Benedict, S. R., The development of algebraic symbolism from Paciuolo to Newton. SSM 9: 375–384.
Boyer, C. B., Fractional indices, exponents, and powers. NMM 18: 81–86.
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Cajori, F., American contributions to mathematical symbolism. AMM 32: 414–416.

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LIGHTNING STRIKES EARTH 100 TIMES EACH SECOND

A hundred lightning bolts bombard the earth every second of the day, each bolt containing millions of volts and from 1,000 to 340,000 amperes of current.

In the U. S. alone lightning kills some 600 persons annually, injures about 1,500 others and causes more than $100,000,000 property damage, according to the Lightning Protection Institute.

Lightning, which can strike twice in the same place, is as likely to strike wood or masonry as it is steel.

SATELLITE COULD QUICKLY CHECK EINSTEIN'S RED SHIFT

A satellite equipped with a clock and special radio equipment could quickly check the gravitational red shift resulting from Albert Einstein's general theory of relativity.

The measurement would take only 30 seconds or less, not the several days or weeks of previously proposed methods.

The gravitational red shift of Einstein's general theroy is an effect that causes clocks to run at different rates when they are in different gravitational fields. The experiment would involve comparing the time kept by a stable clock in a satellite with an identical one on the ground.

If the transmitter on the satellite were operating at a frequency of 500 megacycles, the largest expected frequency difference due to the Einstein gravitational skift would be one-half a cycle, which can be accurately determined with presently available clocks.

PUSHBUTTON TELEPHONES UNDER DEVELOPMENT

A pushbutton telephone device, which may replace the rotary dial, is being developed at the Bell Telephone Laboratories.

The tiny transistor, because of its ability to amplify electronic signals while using little power and producing no heat, makes the pushbutton calling possible.

Each telephone contains a transistorized oscillator that generates two coded musical tones for each of the phone's ten buttons. The tones are similar to those sometimes heard while a long-distance connection is being made.

Simultaneously, the tones are transmitted to a central switching office, from where the call moves on to the recipient. This routing is similar to that of present switching systems, which, however, do not understand the "two-tone language." To make use of existing switching systems, Bell has developed a machine to translate the tones into usable signals.

Ninth Grade Biology—Pros and Cons

William W. Sharkan
Science Teacher, Raub Jr. H. S., Allentown, Pa.

As a course, biology entered the secondary-school curriculum about fifty years ago, and statistics today show that the majority of high-school tenth graders in our country are enrolled in this course.

Most biology teachers have considered the tenth year of the total school program as the proper "niche" for the teaching of their subject followed by a sequence of physics and chemistry in the eleventh and twelfth years. Recently, because of plenty of publicity, suggestions have been made that biology be offered in the ninth grade. This will allow another year of advanced science in the high school. Biology has been picked over physics and chemistry because it is a non-mathematical high-school science, because it is the first science course most students elect in high school, and because it requires less manipulative skill and dexterity than the physical sciences.

There have been many pros and cons about this exciting but not new idea. Some will be discussed.

Pros

It is expected that during the next five years a considerable portion of the material covered in the ninth-grade general science course will be introduced in the elementary-school science programs and completed in the strengthened seventh- and eighth-grade science program. Therefore, when this is done, one will gain a year in the science program. All subjects are moved down one year, and an advanced program is set up.

Chemistry and physics are more specialized sciences which require more elaborate equipment and changes in the physical environment of the school. Likewise, reiterating what was mentioned previously, they require more of a mathematical background than the other laboratory science biology.

Biology has also been recommended over an earth-science course. The preparation of biology teachers has been well defined by the certification requirements by the various state departments of education; the preparation in the way of certification requirements for earth science teachers is still nebulous. One realizes that the teacher's interest and enthusiasm are paramount to good teaching, and one realizes the fact that some poorly-prepared teachers can't teach a comprehensive and vigorous earth-science course. Likewise in existing areas where it is being taught in the high schools, there has been a tendency to place pupils in the course who do not seem to be fitted for chemistry or physics. Connotations of the course imply that it is just

right for the science-shy student. Another reason for emphasizing biology in lieu of the earth-science course is that concepts and principles of meteorology, astronomy, geology, and conservation will be included in the elementary-school science programs because of the interest and ease of presentation. Hence, the ninth grade program would be a rehash of what went on previously, eventually prostituting it to the same level as the general science course is in many schools of our country today.

The introduction of ninth grade biology will strengthen and broaden the *over-all* four year science training of selected students. In many cases, more work will be required from the students in the ninth grade biology course than the regular general science course being taught in the school at present. Likewise, this introduction will satisfy the demands of the critics of American public education by raising the standards of scientific education so that students start to motivate themselves towards a college education earlier and will help eliminate the supposedly "snap" courses that they are taking.

The introduction of ninth grade biology will allow the gifted students to gain one year through school and will allow them to enter college with advanced standing in the courses whose requirements they have met. This is becoming extremely more important in our professional world when more years are spent getting M.A.'s and other advanced degrees.

High school biology as taught now is a terminal subject for the majority of the students; therefore, to be successful, a new approach is needed in the teaching of biology in the ninth grade or it will be doomed from the beginning. The systematic study of plant and animal structures can't be taught in ninth grade and be successful. Many critics of biology today have said that the learnings in the course were too verbal, too superficial, and too quickly lost to the students after a quiz in the subject.

Ninth grade biology must be a functional biology course designed to suit the needs of the students in the junior high school. During the ninth grade one finds dynamic changes taking place in the growing boy or girl. The pubescent spurt and the onset of adolescence focuses one's thinking on himself as a biological mechanism and supports the teaching of a functional ninth grade biology as the opportune subject at the appropriate time.

The introduction of ninth grade biology will allow all students the opportunity to take a biology course rather than only those in the college preparatory course and the general course. Vocational and commercial students in many school districts are not given this chance. Besides this, many students quit school in the formative years of high school without the benefit of a good biology or hygiene

course. This ninth grade program will give them the scope of the course that is required for the citizens of our society to live better today.

Cons

The greatest disputation against introducing ninth grade biology in areas where it does not exist is that of the maturation factors in children relative to the placement of biology.

Without adequate proof and experimental studies, critics have said that the maturity saltation of one year between the ninth grade and the tenth grade is exceptionally significant in the teaching of biology. They go on to say that ninth grade students have not matured enough to assimilate the subtle and complex relationships that are taught in the study of heredity, evolution, and reproduction of a *tenth* grade biology course! A recent article "Concerning Ninth-Year Biology" by Philip Goldstein appearing in *The Science Teacher* (December, 1958) has been debated heavily and used as ammunition against the introduction of a ninth grade biology course even though it was one small isolated accidental experiment with statistical evidence based upon the distribution of scores on the New York State Regents Examination in biology, June, 1958. According to his article, the introduction of ninth grade science definitely does not strengthen the biology training of the students in his course. It was not supposed to! It concerned the over-all four-year science program.

Many educators in our profession have said that general science, biology, physics, and chemistry represent a basic skeletal articulation which has been tested to parallel constantly the maturity levels of the students and the teaching of ninth grade biology will require the chemistry and physics programs to delete important theoretical concepts if they are to reach the groups who take the subjects in the tenth and eleventh grades. Again, if we consider tested to mean it has been done this way for the last fifty years, one can agree with them; however, there have not been experiments to contradict the shifting of biology to the ninth grades. Many school districts have done so.

One can mention briefly here without knowing the entire experiment the *Early Admission Programs* sponsored by the Ford Foundation. One remembers that 420 boys and girls, most of them sixteen or younger who completed tenth grade, were given Ford scholarships to go to college. The young scholars demonstrated to the skeptics that a *gifted* student can skip a year or even two years of high school and still adjust socially, emotionally, and academically to college life without benefit of the eleventh and twelfth grade maturity factors! Likewise, our many great forefathers graduated from college at a rather early age. One can remember reading that Samuel Adams

graduated from Harvard University at the age of eighteen; likewise, John Hancock graduated at the age of seventeen from the same school! Thomas Jefferson, a great man to try to emulate, graduated from William & Mary University at the age of seventeen! One realizes that schools and colleges were different then, especially the colleges that were equivalent (?) to our secondary schools of today. However, one must face the truth and say that maturity saltation of the years and the maturation factor had not retarded these many greats from our great American heritage.

Another reason for not placing biology in the ninth grade is the problem related to the equipping of laboratories when school systems are on the 6-3-3 plan. Eight thousand dollars would provide an adequate biology room. There would be a great financial stake in this costly experiment by many school districts who can not afford it at the present but who feel they are not chic if they do not initiate it promptly.

Science coordinators and science study outlines presenting the entire school program from kindergarten through grade twelve are prerequisites for a successful program. Most schools do not have any and operate on a hodgepodge arrangement with duplication given quite frequently. The shifting down of ninth grade general science and the introduction of the elementary school science program requires adequate articulation and integration before the ninth year can be given over to biology. Too many schools have ***paper*** programs and that is all!

High school teachers do not relish the idea of going to a junior high school to teach because of changes in procedure, certification requirements, and other administrative chores. Those who remain in the high school are adequately prepared to teach advanced courses but lack the experience and the course outlines that would be effective to make the results successful. Teacher placement and teacher replacement would pose as major problems.

Finally, ninth grade biology will result in a "watering down" of *tenth* grade biology material to the extent that biology will lose its great appeal as a high school science and end up as a glorified nature-study course.

Discussion

Most of the pros and cons given in the article are "glittering generalities" without documentary evidence to substantiate them. Likewise, each pro and con could be discussed more thoroughly depending upon one's outlook and educational background.

There is a need for more experimental studies in the fields of science regarding these controversial issues. The field of biology will be

re-examined just as the physics program has been done by a group from the Massachusetts Institute of Technology. There have been too many fallacious discussions based upon purely subjective observations with a dearth in proofs, surely not the scientific way!

Some of the basic questions one must ask himself about biology in the American Curriculum are: How does biology fit into the pattern of general education for all high school students? Will the understanding gained from a year of biology enable graduates to live better in our dynamic society? What actually are teachers trying to accomplish in their year of high school biology? Are goals today for biology realistic in terms of the students, their needs, and the time factor? Are *all* objectives, or merely a few, being evaluated?

Answers to these questions and a careful evaluation of the overall and long range effects of the ninth grade biology program on the *entire* curriculum are needed before we can say definitely ninth grade biology.

AEC SCIENTIST DISCOUNTS DANGER OF OFF-SHORE WASTE DISPOSAL

The possibility that radioactive wastes, dumped in coastal waters, might harm human beings or fish is almost non-existent, according to an Atomic Energy Commission biologist.

He said scientific evidence gathered by the AEC supports the contention that it is "practically ridiculous" to expect genetic damage to result from radiations emitted by materials in the steel and concrete disposal drums.

Studies on the problem have been completed or are now in progress at Laboratories of the U. S. Fish and Wildlife Service, the University of Washington, the Woods Hole Oceanographic Institution, and elsewhere.

The results were negative for amounts of radioactivity equivalent to those contained in disposal drums. The first detectible genetic damage was found after fish were irradiated with 25 roentgens of hard X-rays.

AEC has estimated that the drums, when first sunk, emit anywhere from one-hundredth to one roentgen an hour. The radioactivity lessens, however, gradually for some isotopes and rapidly for others, becoming less likely to produce damage.

Much of the waste consists of tritium, and its beta radiations are so weak they cannot penetrate human skin.

An important reason why the danger can be minimized is in the nature of the disposed wastes. Much of it consists of iron piping, broken glass, filter paper, and discarded coveralls. Should a drum break open, you could hardly expect a fish to make a meal of broken glass and coveralls.

In addition, the quantities of radioactive materials are so small that even if a fish somehow got into a waste drum it would have to stay in the confines for quite a long time before it would be exposed to the slightest statistical probability of genetic damage.

The Real Menace of the Sputniks to Mathematics Education

Herman Rosenberg
New York University, New York, New York

Introduction: the Challenge of the Sputniks

In the fall of 1957, the news of the success of the Russians in launching their first sputnik satellite set off an "explosion" in American education. Of course, prior to this event many of our American educators had exhibited considerable concern with the problem of reform in mathematics education.* However, the sputnik incident fostered an acute awareness of serious danger to our national *security*. The result was the creation of an atmosphere in which the need for reform in mathematical education assumed tremendous urgency. Hence, the dramatic shocks generated by the sputnik situation led many, many educators to a point where they were ready for *immediate* planning and action.

In general, the vigorous American attempts to examine our mathematics education and to evaluate it in the light of the Russian challenge have been praiseworthy. However, the grave danger that we face is the possibility that some of the finest aspects of American mathematics education may be scuttled due to *hasty* action based upon improper "understandings." The remainder of this article is concerned with the analysis of three basic current "misunderstandings." These fallacies center about three pivotal elements in American mathematical education:

1. The basic nature of the mathematical *curriculum*.
2. The key "*personnel*" in mathematics education.
3. The fundamental *agencies* in the education of mathematics teachers.

Sputniks and the Mathematics Curriculum

The battle of the sputniks has been at least partly responsible for the emergence of a startling fallacy concerning the proper nature of the mathematics curriculum. The fallacy is the view that, in order to "beat" the Russians, *all* students in American schools must be forced to study more mathematics and more difficult mathematics. Thus, recent suggestions have included the proposal that the mathematics program be strengthened by introducing such requirements as:

1. A "complete" course in elementary algebra for all junior-high-school students in the eighth grade.

* See, for example, the sharp criticisms of American mathematical education in: Dyer, Henry S. and others, *Problems in Mathematical Education*, Educational Testing Service, Princeton, 1956.

2. A course in calculus for all senior-high-school students.

Now, perhaps the most serious threat to American mathematics education arising from the entire sputnik affair is the terrible possibility of casting aside the precious doctrine of recognition of "individual differences." Our mathematics students differ tremendously in their mathematical needs—the amount of mathematics needed, the kind of mathematics needed, the rate at which such mathematics may be absorbed, etc. The very limited mathematical needs of the retarded child who (possibly due to partial or complete loss of hearing) can hardly communicate with others are radically different from the very great mathematical needs of the gifted child who is ideally suited for a career involving creative uses of mathematics. The terminal mathematical needs of the high-school students in general education differ considerably from the preparatory mathematical needs of the high-school students who plan to specialize in mathematics. In the light of the existence of varying individual needs, it is truly sad to contemplate the suggestion of some educators that *all* students must be given programs of modern mathematics—even though there has not been first an investigation of the possibility that for some of our students certain concepts of modern mathematics may be much too difficult and/or of little value.

Indeed, the suggestion has been made that the "fun" must be taken out of mathematics and must be replaced with "challenge." But a calm (and possibly at least slightly more "sane") approach would carefully consider the basic psychological nature of our teenagers and their attitudes toward mathematics. The realistic fact is that too many of our students at the present time have found their mathematics much too difficult (i.e., "excessively challenging"), uninteresting, and somewhat repulsive. The fundamental psychological principle of stimulating the study of mathematics via appropriate motivation (such as the "fun" incentive) remains sound. In mathematical instruction, "fun" and "challenge" need not be conflicting themes. The ideal teaching situation would seem to be one in which our students find their study of mathematics to be immensely attractive because of the provision for *both* "fun" and "challenge." The really essential psychological principle to be retained in mathematical instruction is the principle of determining and providing the "necessary and sufficient" amounts of "fun" and "challenge" needed for differing groups of mathematics students.

If, in the battle of national educational systems, efforts are made to minimize or destroy the psychological concepts of "individual differences" and "human motivation"—those wonderful principles for which good mathematics educators have strived so long and so

hard—, then our present mathematical program can only be weakened. On the other hand, our educational system may be strengthened if these concepts are considerably reinforced by the provision of more interesting, meaningful mathematics programs designed to secure the maximum possible effort, discovery, and learning of value to varying student bodies.

Sputniks and Recruitment of Mathematics "Personnel"

A second fallacy arising from the sputnik race is one concerning the method of recruiting the major "personnel" needed in mathematics education. The fallacy is the view that adequate recruitment of more and better mathematics students and teachers may be based exclusively on the plan of offering "immediate rewards." A pressing need exists for realizing that such suggested programs for recruitment of good mathematics "personnel" lack proper "vision."

Certainly, scholarships for fine mathematics students and fellowships (and similar "fringe" benefits) for pre-service and in-service mathematics teachers are helpful. Such incentives may aid initially in "enticing" some potential "personnel" into being *trained* in the mathematical field. However, much more realistic considerations are required in the field of mathematics in order to *attract* and to *retain* the better personnel permanently.

Experienced and dedicated mathematics teachers hoping to stimulate some of their able students to enter the field of mathematics teaching are quite familiar with the usual candid nature of some responses of these youngsters. Some fairly typical student retorts include these:

1. "Why should I plan to teach a subject like mathematics—which is so difficult to master—when I can plan to teach so many other easier subjects for the same salary?"
2. "If school principals are given higher salaries than teachers because of added responsibility, if salaries of policemen and firemen reflect vocational hazards, if the salaries of bricklayers reflect the economics of supply-and-demand, and if salaries of teachers of handicapped children frequently reflect additional special skills, then how can the single-salary schedule be fair to teachers of mathematics in view of the more difficult training involved and the economics of today's supply-and-demand?"

The recruitment and retention of able mathematics teachers may be facilitated by more attractive teaching salaries. But consideration may also be given to other possible long-range administrative reforms such as:

1. More effective control of illusory "paper" salary schedules for teachers, which, perhaps even more than inadequate teaching salaries, may diminish the enthusiasm of a dedicated mathematics teacher due to the shock to his sense of ethics. Disillusioned mathematics teachers can hardly be expected to inspire others to enter the teaching profession.
2. Fair administration of merit salary systems for teachers.
3. Full utilization of the talents of mathematics teachers in the field of mathematics rather than in other teaching fields for which there is little current "shortage."
4. Evolution of working conditions which release (rather than thwart) the creative energies of mathematics teachers.

The number of dedicated mathematics teachers who can manage to give their best in spite of unfavorable conditions is, of course, limited. If it is desired to attract and retain an adequate number of competent mathematics teachers in the present space age, then it may become apparent that much may be learned from the powerful economic and other methods employed in personnel-recruitment in such fields as medicine, industry, and big business. We must realize that, in general, the kind of mathematics teachers we shall get will be directly influenced by the kind of short-range and long-range "rewards" which we are willing to give.

Sputniks and Schools Of Education

The third major fallacy emanating from the advent of the sputniks is one concerning the basic agencies in the higher education of mathematics teachers. The fallacy is the view that, because of Russian successes, the role of the American teachers colleges, departments of education, and schools of education in the training of mathematics teachers should be reduced or completely eliminated.

In the event of a sudden health epidemic, one would hardly suggest closing our medical schools and hospitals. Thus, the proposal that the problem of the Russian sputniks may be effectively combatted via a "death-knell" for those aspects of higher institutions currently designed to produce and improve our mathematics teachers seems little short of amazing. Some impatience with our schools of education has been occasionally exhibited—particularly in moments of national crisis. But the basic fact is that our teacher-training institutions are confronted with probably the greatest challenge of all training institutions—the tremendously complex tasks of analyzing *human* behavior, determining desirable subject-matter content, and creating appropriate teaching methodology. Many critics of teacher-training institutions appear to have forgotten the "barbaric"

role of the medieval barber as a physician and the long struggle of our medical schools for recognition. Some anti-educationists, too, frequently have failed to realize that the inadequacy of some mathematics teachers may be traced, in part, to college departments of pure mathematics where emphasis was placed on the utilization of a mathematics course in future advanced mathematics courses rather than in the prior elementary mathematics courses to be taught by the prospective teaching candidate.

On the contrary, at the present time our teacher-training agencies are, more than ever, vitally necessary. The proposal has been made that they reduce stress on teaching methodology and increase stress on mathematics content. This is debatable, for the capable teacher needs command of *both* mathematical content and good pedagogical procedures. However, like all human agencies, our teacher-training agencies may be improved by various techniques. Such techniques may include the recruitment and retention of a more effective staff (via, for example, better salary conditions) and a better integration of teaching methodology and mathematics content. It may well be that the future of American mathematical education will lie in the research activities of such agencies—research designed to explore in a sane, scientific manner such problems as the nature of the most effective mathematics curriculum and the most effective methods of "personnel" recruitment in the light of the challenge of the modern space age.

Concluding Remarks: The Balance Sheet[1]

Fortunately, there are some *encouraging* signs. Within recent months there have appeared in the literature some notable and courageous attempts to present relatively careful and thoughtful expositions of the problems discussed in this article.

Thus, the Commission on Mathematics of the College Entrance Examination Board, in proposing its program of modern mathematics for what it called the "college-capable" students, expressly stated: "We do not believe, however, that this means that the entire school population should be required to take exactly the same program."[2] Again, interest in the problems of our *slow* learners has been expressed in recent articles by Boyer[3] and Sobel.[4] While, of course, it is highly imperative today that we strengthen our mathematical curriculum

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[1] This section of this article was written by the author in the spring of 1959, whereas all preceding sections were written in the summer of 1958.

[2] *Program for College Preparatory Mathematics*, 1959, p. 10.

[3] Boyer, Lee, "Provisions for the Slow Learner," *The Mathematics Teacher*, LII (April, 1959), pp. 256–259.

[4] Sobel, Max, "Providing for the Slow Learner in the Junior High School," *The Mathematics Teacher*, LII (May, 1959), pp. 347–353.

for our "gifted" students, it is encouraging to observe that imperative efforts to improve our mathematical curriculum for the "less gifted" students are not being completely ignored.

It is also encouraging to note recent realistic efforts to cope with the *general* financial problem of the teaching profession. While analyzing the efforts of those who have tried to use our schools as a "scapegoat" for previous technological reverses, President Carroll V. Newsom of New York University has called attention to the dangers involved in the failure of public citizens to give sufficient financial support to schools and colleges. He has noted that the insistence of Americans that " . . . colleges and universities operate upon a bare subsistence level in an age of plenty provides strong evidence of an inherent lack of understanding of education. . . "[5]. The writer has been informed that Secretary of Health, Education, and Welfare Arthur Fleming has pointed to our salary structure as the most serious current weakness of our educational system. The prize-winning author of *The Challenge of Soviet Education* (1957), George S. Counts, has recently expressed his view that education must be regarded " . . . far more seriously than ever before in our history. . . . This means further, and most particularly, the raising of the qualifications and the material and spiritual rewards of the teacher at all levels. . . . The attainment of this goal might well double the cost of education. . . . Our very survival as a free society in the great ordeal through which we are destined to pass may well depend on these things. . . ."[6]

With respect to the more restricted financial problem in the field of *mathematics* education, Burton W. Jones has recently given some thought to this matter. He has concluded: "If we are to attract ambitious young men to secondary-school teaching, it is imperative that we give monetary recognition to merit."[7] The former president of the National Council of Teachers of Mathematics, Howard F. Fehr, has recently advocated higher salaries for those mathematics teachers who have demonstrated excellence in *scholarship* in their training. He writes: " . . . The United States is one of the very few countries in the world today that rewards all teachers—kindergarten through junior college—with the same salary for the same length of service (not according to the type of teaching, or skills and intellectual attainment involved). This may be what our country wants. If so, then what does it profit a high school teacher to become more

[5] "Newsom Rejects Scapegoat Role Forced on Colleges," *The New York University Alumni News*, IV (November, 1958), p. 1.

[6] Counts, George S., "The Real Challenge of Soviet Education," *The Educational Forum*, XXIII (March, 1959), pp. 268–269.

[7] Jones, Burton W., "Silken Slippers and Hobnailed Boots," *The Mathematics Teacher*, LII (May, 1959), p. 325.

ambitious in his teaching or in his pursuit of knowledge? Of course there is a basis for equal salary from a social point of view, but in its *civil and social service*, society must be efficient. Today, it is becoming more and more evident that the most efficient society will eventually dominate the world with its political and economic philosophy."[8]

In the judgment of the writer, the general problem of personnel recruitment in education will not be solved by concentration *exclusively* on the needs of mathematics teachers. While this article has been specifically concerned with the problems of mathematics education, it is realized, of course, that realistic and sound financial considerations may be needed to recruit and retain an adequate supply of the urgently needed superior teachers of science and *other* fields. (The danger of our neglect of the humanities and the social sciences is very real.) It should also be realized that while financial aspects may play a significant role in the general problem of personnel recruitment, finances *alone* cannot solve our problems. The paramount need for a truly *balanced* view in education cannot be overemphasized—particularly if the menace arising from the battle of the sputniks is to be regarded as a supreme *challenge* which can and must be met with *both* vigor and wisdom.

[8] Fehr, Howard F., "How Much Mathematics Should Teachers Know?" *The Mathematics Teacher*, LII (April, 1959), p. 300.

MOLTEN SALTS SUGGESTED FOR REACTOR FUEL

A better fuel for high temperature nuclear reactors than the uranium metal rods now in use may be uranium salts which are mixed with other molten salts. So says an authority on molten salt chemistry, basic also in metallurgy and ceramics.

Uranium metal rods have two major disadvantages. They lose their shape when exposed to radiation from the fission process. And they do not work continuously, since the rods have to be taken out of the reactor to remove impurities caused by fission products.

Reactors using molten uranium salts may overcome these disadvantages. The salts, in liquid form, do not change shape, and can be continuously purified by a cycling process, in which the liquid is pumped out, purified and returned to the reactor.

On the other hand, the use of molten salts raises some new problems, such as finding the proper material for the salt containers. Important investigations along these lines have been reported by the Oak Ridge laboratories.

A bulletin of The Appalachian State Teachers College, at Boone, North Carolina, entitled "Faculty Publications—1958" has an interesting short article "A Mathematical Master Key" which points out how the prismoidal formula could possibly replace several of our commonly encountered formulas. No doubt anyone interested could receive a copy by writing the college.

Methods of Presenting a One Year Integrated Science Course

F. C. MacKnight
University of Pittsburgh, Pittsburgh, Pa.

Introduction

An integrated science course is here considered to be one which makes a deliberate attempt to show science as a whole, stressing the interrelations between the various branches rather than emphasizing the separate identity of each of these divisions. It may or may not be a "survey" course, according to what one considers a survey course to be. A course divided into two or three parts: physical, biological and possibly earth science, each part a year, term or quarter, is not considered an integrated course whether or not it succeeds in integrating its own group of sciences, because of the failure to properly unify the separate courses of the set. Nor is a course which takes pains to relate natural science with the humanities or social sciences considered integrated in the sense used here if it does not interrelate the various divisions of science. Also, any course longer than a year is difficult to integrate properly even if an attempt is made to do so.

The position that an integrated science course is desirable as an introduction to science at the college level—that it should be the "field" requirement in colleges—was argued in a previous paper presented at Section Q of the AAS at Indianapolis in 1957 and published in this journal February, 1959. The reader who questions the value or advisability of such a course is referred to that paper. Here the premise is accepted without further argument.

Part I—Integrating the Natural Sciences

In discussing the usefulness of an integrated science course, the query arises as to just how integration may be achieved. It is the purpose of this paper to explore some ways by which it may be done. Those discussed are:

A. A sequence of merging topics arranged to take up each science at a point where it has common ground with the one previously considered.
B. A chronological approach, starting with mathematics and ending with psychology.
C. The geologic approach, using the framework of a course in geology to bring in the basic sciences.
D. A "philosophy of science" approach, with a formal treatment of scientific method illustrated by examples from all sciences.
E. The case method, using a variety of topics each of which is a fusion of several sciences.
F. The unifying idea method, attempting to relate all science through a single idea.
G. Combinations of the above.

A. Sequence of Merging Topics

This method, chosen by the Core Curriculum Committee in Natural Sciences at the University of Pittsburgh, may be exemplified by briefly describing the Pittsburgh course, which was the invention of Dr. Christopher Dean, Associate Professor of Physics. It is constructed of five units:

1. The Evolution of Earth and Life.
2. Celestial Motions
3. The Atomic Nature of Matter
4. The Living Cell
5. The Behavior of Higher Organisms.

Each of the units stresses one *main* idea: The relevant date, the historical development of the explanatory theories, and some consequent developments are presented. In stressing the main ideas, other subordinate ideas must be mentioned, and each unit is joined to the next by connecting material so that the transition is natural and logical.

A topic to topic résumé of the course will illustrate the method of "merging."

The course starts with an examination of the state of scientific knowledge of the earth in the early 18th century (which is not significantly different from that of most laymen of today). The evidence for a dynamic rather than a static earth is examined, and the reasons for preferring the theory of Uniformitarianism rather than the opposing interpretation of Catastrophism. Consideration of the fossil controversy and the unfolding of the geologic record leads into the paleontologic evidence for organic evolution. This is followed by a brief look at systematic biology and some biological evidence for evolution ending with the experimental or genetic evidence. The introduction to genetics offers a link with mathematics, on consideration of which the development of geometry and mensuration are considered along with the beginning of astronomy. As astronomy is carried to the time of Copernicus it is convenient to study the development of algebra and trigonometry. With Galileo the topic of motion is introduced with a backward look at Aristotelian physics. The triple thread of astronomy, physics and mathematics is carried through Kepler to Newton and calculus, with a side note on the development of modern astronomy and physics, necessitating a treatment of the chemical elements. Another historical regression picks up the alchemists, the development of the gas laws, theories of heat and combustion, and arrives at modern chemical notation and the atomic theory. Radioactivity brings a synthesis of physics, chemistry and geology in isotope chronology. It is only a slight shift of subject here to consider the physical chemistry of the living cell, bringing back biology through cytology; thence to the physiology of

muscle, nerve and the special senses (particularly the eye), to the central nervous system, learning, behavior and intelligence.

It is probably unnecessary to state that *complete* coverage of each topic is regarded as neither possible nor desirable at this level.

Scientific method may be introduced gradually, along with the other topics, or as a unit to itself, coming conveniently at the end of the first term or the beginning of the second, a good place to take stock of what science is trying to do and how it has done it. Thereafter some general principles are available with which to correlate further developments.

No claim is made that the above arrangment is the only good one, or even the best. With some ingenuity it seems likely that equally good arrangments could be made by proceeding from any part of science to any other part by similar method. We chose to *start* with geology for these reasons:

1. The course being designed for all entering Liberal Arts freshmen, regardless of their background or interest in science, starting with a new non-high school science tends to equalize other student differences. Those with poor high school backgrounds will not be at an initial psychological disadvantage and those with little interest may get a fresh slant on science.

2. A descriptive and dominantly non-mathematical science may be better as a starter for similar reasons.

3. The opportunity for an early Fall field trip allows quicker rapport between instructor and students, as well as between students, helping remove some of the social barriers to successful classroom discussions more quickly.

But equally cogent arguments may be made for starting elsewhere, particularly with mathematics.

It is noteworthy that most of the topics in the Pittsburgh course were handled in a historical fashion, bringing the student from the past to (or nearly to) the present, though the course as a whole was not so treated. This is not to be considered a necessary part of the integration, which can be achieved equally well without any reference to historical background. It was considered useful in (a) helping class discussions in a subject normally too authoritative to elicit much, and (b) in avoiding authoritarianism as much as possible by building up knowledge in the way it actually developed. Likewise the convenient Principal Ideas, or "unit," of the Pittsburgh course are not a necessity for this type of course. It might be preferred to slide from topic to topic without any particular stress.

B. A Chronological Approach

Treatment of the entire course like a History of Science is an at-

tractive possibility, allowing the chronological method to determine topic order instead of being subservient to it. Such a course would start with early mathematics and astronomy, move along through classical antiquity, the dark ages, middle ages, and renaissance, picking up the various sciences as they become important, and ending at modern times. Each temporal division would be treated as a unit, integration being supplied by carrying the various trends of scientific endeavor simultaneously epoch by epoch and relating them by their similarities or contrasts in method.

This approach would have the advantage of nice correlation with a similarly arranged humanities survey given the same students at the same time. The historic method is also a safeguard against the tendency to overestimate the certainty of contemporary science.

Some disadvantages are peculiar to the pure historical type course.

There are several good History Science texts but none are for the scientific novice. They would need considerable augmentation by class presentation of background material.

It is not easy to keep up continuity in following the threads of the separate sciences by the suggested time unitization.

There will be a tendency to lag in the early part of the course so that contemporary science may be neglected at the end. This is true of the usual History of Science course and is even more likely where so much more must be explained as one goes along.

The historical treatment at this superficial level has a tendency to mislead students as to the nature of modern scientific activity by overemphasizing the great man theme. One must guard against imparting the idea that all scientific advance has been made by individual geniuses.

However, the above difficulties are not considered insuperable but merely as challenges that must be met consciously. It may be noted in passing that a straightforward presentation is not the only possibility. One might start with the state of science in the renaissance, going backward first to pick up the background, and then forward. This is appropriate since much of our present knowledge of classical science was discovered during the renaissance.

C. The Geologic Approach

This might be put under a more general classification such as Using the Framework of a Systematic Course in One Science to Bring in the Others at Points of Contrast. This might be done for any science if one tried hard enough but certainly geology makes the most natural subject for the experiment.

If, in a semester course in physical geology, one does not merely presuppose prior knowledge of physics or chemistry but instead takes

time out to build them up as they become necessity, one can cover a good bit of basic work. Even mathematics can be worked in through the physics and chemistry if not through the geology directly. In historical geology, one normally gets a fair amount of biology, and the problem of the origin of the earth is good entrance for astronomy. Even psychology could be added as a finale brought in by the coming of Man in the Pleistocene.

Such a course must neglect much of traditional first year physical and historical geology—the part that does not integrate so well with the other sciences; but even so, some geology texts could be used as a student guide. In this respect the geology centered course may be a more practical method than the others suggested here. But this plan may be criticized on the following grounds:

(a) The student will get a good measure of geology but fragmentary amounts of the other sciences. *Reply:* In any year general science course one gets only a fragmentary amount of each science. If in this case he gets more than a fragmentary view of one science he is not the loser. It is possible to work in enough physics and chemistry to actually crowd out most of the geology in such a course. All the topics that one would normally consider suitable for a first year survey can be worked in naturally save electricity and light, which are awkward to introduce directly from elementary geology. Light can be brought in along with astronomy.

(b) The instructor of such a course would necessarily be a geologist. *Reply:* A geologist would probably work best in this situation, but this is true of other general science courses too. Geologists are likely to have a broader scientific training than other scientists, and are better prospects for teaching general science courses at college level. The real objection here is that it would be a temptation for the teacher to relapse into a normal first year geology course, neglecting the integration aspect. It actually might be preferable for a non-geologist to conduct this type of course.

D. The "Philosophy of Science" Approach

This would organize the course around an outline of scientific method. It would involve individual and original work by the instructor in working up his own outline. (Books meant for philosophy courses in Logic and Scientific method will not be found suitable for this project.) Choosing instances in proper balance and breadth to illustrate the principles will also require considerable knowledge and ingenuity. However, there are a variety of references that might be

suitable for student reading, like the Harvard Case Studies in Experimental Science. But if these difficulties could be overcome, this type of course might achieve integration with more economy than the other types with as good a spread of subject matter as any other type course can achieve. An outline of such a course could be the subject of a paper in itself and will not be further considered here.

E. The Case Method

Here the scheme is to study a number of units or cases of problems involving more than one science for their understanding. It differs from type A (Sequence of Merging Topics) in that there is no definite attempt to interrelate the cases themselves; the integration is all achieved within the separate cases; the over-all effect integrates science as a whole. This method is used in Wistar's *Man and His Physical Universe:* an integrated Course in Physical Science, Wiley 1953. It is used to still better effect in a general science course where there is no need to restrict the cases to those which are in the physical sciences alone.

An example is the study of the climatic zonation of the earth, involving a union of physics and biology through the bond of meteorology—rotation of the earth, Coriolis effect, wind motions, ocean currents, climatic zonation and vegetation. This might be extended to include laws of motion, falling bodies and planatary motions at the beginning; at the end, zoogeography and its geologic background. Examples of other suitable topics are:

The special senses: the eye, light and vision; the ear and sound, etc. (Physics, chemistry, physiology, psychology.)
Public health problems. (Bacteriology, chemistry, geology.)
The Age of the Earth. (Geology, physics, chemistry and possibly astonomy.)
Organic evolution and genetics. (Geology, biology and mathematics.)

It will not be necessary to use many such topics to get a satisfactory sampling of all the sciences. Probably a few topics well treated would be better than many treated more lightly. As few as four well chosen topics should make a good year course. Possibly even two, one each term, would be successful.

F. The Unifying Idea

This might be considered a special instance of the case method, where one case is stretched to include all science if possible. An example might be made here of a scheme devised by Dr. T. E. Cartwright, of the Biophysics Department of the University of Pittsburgh.

The entire spread of natural sciences is related to the central idea of *energy*. First the concept of energy is evolved deductively starting with a presentation of current atomic theory (necessarily authoritative in that evidence for it is not considered at the outset); thence valance, ionization, electricity, gas kenetics, vanderWaals forces, chemical reactions, and potential. Energy having been established, it is used as a "platform" from which one may proceed in any direction. E.g.:

Sources of energy: radiant—sun; stars.
fixed—photosynthesis; in rocks.
Release of energy: heat, mechanical, chemical, electricity, life.

Any and all branches of science may thus be brought into whatever extent desired.

Other central ideas around which a whole course might be constructed are:

Entropy and its "opposite," Homeostasis. This is another viewpoint for the energy idea.

Evolution—biological, geological, stellar. One can force much science into this concept.

The Earth. The geologic approach might be considered a case of the unified idea method.

The Universe. A broader approach, starting with the methods of astronomical and astrophysical investigations, mathematics, physics, chemistry; through the stellar universe, the solar system; and ending with the earth, its fauna, flora, and man. However, this "unifying concept" is so broad that this is merely another method of the "merging topic" plan.

G. Combinations of Other Types

The Pittsburgh course might be considered a fusion of the Merging Topic type, the Historical type and the Case Study. Another possibility considered and rejected by the Pittsburgh committee was: first term—a brief history of science carrying to the twentieth century only; second term—first a brief systematic treatment of scientific method, then a few case studies illustrating twentieth century science.

Another combination of the same elements can be found in that pioneering work by R. E. Lee, *The Backgrounds and Foundations of Modern Science:* An Integration of the Natural Sciences for the Orientation of College Freshmen, Williams and Wilkins, 1935. This contains four parts: the first is on scientific method and the philosophy of science; second, a chapter by chapter overlook of the various separate sciences; third, a short history of science; fourth, a special

"case study" of matter, energy and atomic theory.

Any number of further combinations may be devised as well as general types different from and perhaps superior to those described in this paper. It is unfortunate that with all these possibilities there are at present no texts available from American publishers for the collegiate integrated General Science course.

Part II—Adding the Social Sciences

The efficacy of a one year science course is often questioned on the grounds of difficulty of complete coverage. It is held that it is better to restrict the breadth of the course to, say, physics, chemistry and biology, than to bring in more than can be assimilated. (Psychology may be omitted because in many schools it is not grouped with the natural sciences.) But one of the principal advantages of this type course is in introducing the "minor" sciences and increasing the student's perspective. And this does not involve sacrificing the objectives of Showing What Science Does and How Scientific Knowledge Is Gained. A more cogent question is whether the scope of this type course might not be extended to include the social sciences. Can this be done without ridiculous dilution of each? What would be the advantage of joining these "divisions"?

Reasons for keeping the Natural and Social Sciences separated in introductory survey type courses are plain enough. E.g., "It's bad enough to consider compressing the whole spread of natural sciences into a one year course; to add social sciences is preposterous." Or, "The Social 'Sciences' are not really sciences and should be excluded." The first of these attacks the problem on the line, "Can it be done?"; the second, "Should it be done?" These questions will not be debated thoroughly here, but a few relevant points may be made.

In two parallel courses in Natural and Social Science great attention to Scientific Method is accorded by both. If the Social Sciences *are* sciences, this repetition could be saved by a union.

The same arguments advocating the coalition of physical and biological sciences (artificiality of the distinction, the unity of science, intermediate position of some sciences, etc.[1]) may be applied to the Natural and Social Sciences. Psychology, anthropology and geography are intermediate between Natural and Social Sciences; sociology is close to the Biological Sciences.

The disparagement natural scientists frequently exhibit toward social sciences is often a matter of prejudice and ignorance, and the same attitudes exist within the natural sciences themselves. The social sciences occupy the lowest position in a hierarchy, topped by physics

[1] See MacKnight, *op. cit.*

and chemistry, based on relative *control* or *predictability*, the use of mathematics, and experimentation as opposed to mere observation. These contrasts of natural and social sciences can better be brought out directly in a single course than inferentially in two courses.

It would save time on crowded student schedules if one general course could serve the purpose of two.

On the other hand, it must be borne in mind that many Historians, Economists and Political Scientists do not consider themselves scientists or their field *science* in the normal sense. Finally, the placement of the Natural and Social Sciences in different "divisions" of a faculty often makes it difficult to effect a union because of university policy. However, the questions here are "*can*" and "*should*," not "*may*."

From the above, a tentative decision might be made that from the viewpoint of showing a complete range of the contrast between the types of scientific endeavor, and of saving space on Scientific Method and time on student's program, it might be well to devote some time to the Social Sciences if the course would not be seriously weakened by the inclusion.

If the course merely mentioned the Social Sciences only to the extent of defining their subject matter and remarking upon their methods, their resemblances with and differences from the natural sciences, the best reasons for including them would be satisfied. Such a course probably should not be considered as counting toward satisfaction of the Social Science requirement, but merely as an introduction to further courses in the area. An arrangement of this sort would work best in the History of Science type course, where the social sciences would be mentioned briefly at the end of the course, except for history and possibly geography, which rate earlier entry.

The Merging Topics type seems poorly adapted to the addition of further material. The Geological Approach, on the other hand, offers surprising connections with the social sciences. Geography enters naturally. Economics might come in through mineral deposits. Anthropology and history could accompany psychology with the Coming of Man at the end of Historical Geology. But such inclusions may well "water down" the course far past the point of effectiveness.

The Case Method can easily be applied to the social sciences. The examples cited of Climatic Zones and Public Health spread over Social Sciences too, and a number of still broader topics are easily found. The origin, development and use of iron ore or other mineral products involve chemistry, geology, geography, economics and political science (geopolitics). But here again there may be a danger of introducing social sciences only at the expense of the natural sciences.

The Unifying Idea could best include social sciences with Evolu-

tion as the main theme. Sociology and anthropology would fit in well with this idea.

The Philosophy of Science approach offers the best chance for an equal or nearly equal treatment of the social sciences. So many scientific concepts are best introduced to the student by examples from the social fields with which he has had more experience. The nature of this type of course should permit the inclusion of social sciences without materially weakening the total content or limiting the spread of natural sciences covered.

Finding an instructor sufficiently conversant with the social sciences to handle the additional work seems difficult, but the generalist or polymath fluent in all the natural sciences will probably be able to cover even more with equal effort (which, however, is certainly not inconsiderable).

MUSEUM BONE FOUND TO BE 35,000,000 YEARS OLD

A tiny piece of bone that has been in the American Museum of Natural History in New York for 50 years has been identified by a Princeton University paleontologist here as being 35,000,000 years old.

Thus, it is part of the oldest specimen yet discovered of a skull of the higher primates, the group that includes monkeys, apes and man.

Measuring less than an inch in diameter, the bone was deposited in a quarry in Egypt in the Early Oligocene Age. It was found about 50 miles southwest of Cairo about a half century ago by an American-Museum-sponsored expedition.

Several scientists regard the find as a reinforcement of the belief that there were several kinds of monkey-like animals living in Egypt in early Oligocene times.

NEW TECHNIQUE TO MAKE FABRICS INSECT-PROOF

A revolutionary new approach promises lifelong immunity for fabrics against textile-destroying insects which cause millions of dollars damage annually to carpets, upholstery and clothes.

The new technique has been developed by an entomologist at the University of California, Los Angeles.

A colorless, odorless, harmless (to humans) compound can be used to impregnate fabrics during the dye-vat process, rendering the material "indigestible" to carpet beetles, clothes moths, and other insects for the fabric's lifetime.

It can also be applied in an aqueous solution to existing fabrics in the home.

The compound is one of a group of substances known as antimetabolites. Antimetabolite compounds are structurally similar to essential nutrients such as vitamins. Very slight differences in chemical structure are just enough to cause them to be "misfit" links in the insect's metabolic chain.

After the young insect ingests the vitamin "look-alike" it prevents him from utilizing the essential nutrient. (Vitamins in fabrics are supplied by spilled food and drink, skin secretions and other types of soiling.) As a result, a sort of beriberi sets in, causing the insect to die of nutritional deficiency.

However, in some little-understood manner the mature insect recognizes the antimetabolite after the first or second "mouthful" and will leave impregnated material for "greener pastures" before any real damage is done. Thus, in effect, the fabric becomes immune to insect attack.

A Simple Spark Point Counter for Demonstrating the Range of Alpha Particles

George E. Bradley

Western Michigan University, Kalamazoo, Michigan

The detection of alpha particles can easily be performed with only a sewing needle and a low current 5000 volts dc power supply.

The ionization of air by the passage of alpha particles can initiate a momentary spark discharge in a region where the electric field is just short of producing a breakdown. This effect is employed in Geiger tubes where the breakdown voltage is usually reduced by using a pressure less than that of a normal atmosphere. In the common types of Geiger tubes the discharge is that of a silent corona which is quenched by organic or halogen additive to the counting gas.

The point counter described here operates in the open air, thus avoiding the necessity of a window which would stop the alpha particles which are capable of penetrating only a few inches of air or an extremely thin sheet of paper. The detector is simply a needle maintained at about 5000 volts and placed near a conducting plate a distance just greater than that which would produce sparking. When an ionizing alpha particle enters the region of high electric field a spark occurs, the flash is seen and a sharp noise is heard. The spark only

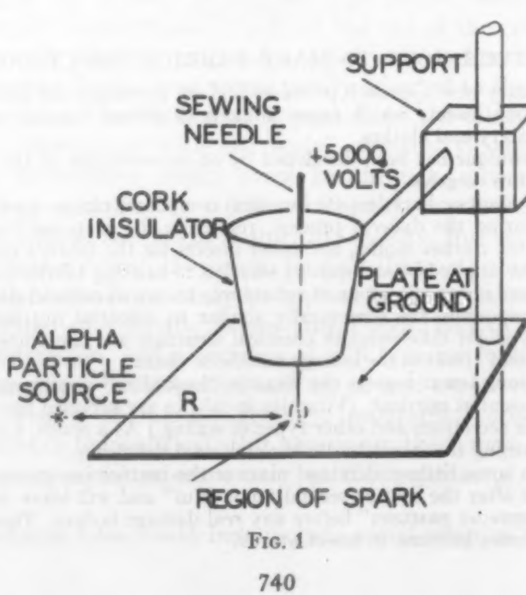


FIG. 1

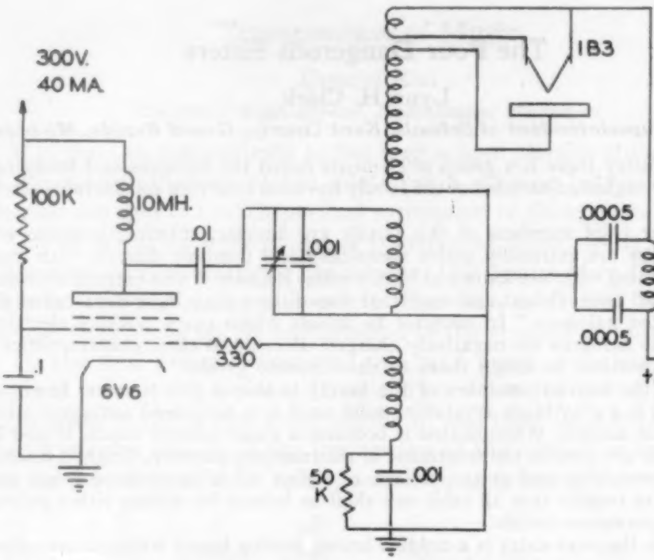


FIG. 2

lasts several microseconds as the power supply capacitor discharges. As soon as the power supply recharges it (about 1/200 sec.) the counter is ready to count again.

The 5000 volts required must be fairly well filtered dc. The accelerating voltage from a television set is suitable. Figure 2 shows a radio frequency type supply which essentially rectifies and filters the voltage of a continuous wave "Tesla Coil."*

The alpha particles used in the experiment are conveniently obtained from a photographic supply shop as the "de-static dust brush" employing a deposited polonium-210 source. The range of the particles can be easily measured by noting the distance between the polonium and the detector at which sparking begins.

The radium paint from a luminous clock dial provides fewer but more energetic (and slightly more penetrating) alpha particles. It is well to remember that the sources herein described, although obtainable without an Atomic Energy Commission license and producing little penetrating radiation, ***may constitute a real and long enduring health hazard if ingested into the body or permitted to enter through abrasions of the skin.***

* Coil. J. W. Miller #4525 Available from any radio part store.

The Four Dangerous Sisters

Lynn H. Clark

County Superintendent of Schools, Kent County, Grand Rapids, Michigan

In chemistry there is a group of elements called the halogens and lately one previously neglected member of the family has been receiving considerable attention.

The four chief members of this family are fluorine, chlorine, bromine and iodine. They are extremely active chemically and combine directly with most metals forming what are known as binary salts. Because of this extreme chemical activity and their violent and unsettled dispositions they have been called the "red headed halogens." In contrast to metals which carry positive electrical charges the halogens are negatively charged. Because of these characteristics it would be possible to assign them to the feminine gender.

Iodine, the heaviest member of the family is almost five times as heavy as water and is a gray-black crystalline solid used as a household antiseptic when dissolved in alcohol. When heated it becomes a violet-colored vapor. It and its compounds are used in the treatment of rheumatism, pleurisy, Bright's disease, asthma, bronchitis and goiter. A lack of iodine tends to produce goiter and many states require that all table salt shall be iodized by adding either sodium iodide or potassium iodide.

Bromine the next sister is a reddish brown fuming liquid which is over three times as heavy as water, and with mercury is the only other element that is a liquid under ordinary conditions. It is used in medicines and almost everyone at some time has taken a bromide for a headache. Silver bromide is used in photography and ethylene bromide is used in the manufacture of high test gasoline.

Chlorine, the third sister, is a deadly greenish yellow gas which was used extensively in World War I, yet when combined with sodium becomes sodium chloride or common table salt, one of our most stable and useful compounds.

In minute quantities chlorine is mixed with the water supply to kill germs and purify drinking water. As chloride of lime it is an effective bleaching agent. It is also used in making dyes, solvents, disinfectants, anaesthetics such as chloroform, and carbon tetrachloride for fire extinguishers. Combined with hydrogen it becomes hydrochloric or muriatic acid, one of our most powerful and useful commercial products.

Fluorine, the last of the red heads, is the most active element known. Fluorine and some of its compounds attack glass and must be kept in wax bottles. However, its affinity for other elements is so great that it forms some of the most indestructible compounds known, some of which are used to produce plastics, lubricants and dyes. Uranium hexafluoride was used in the development of our first atomic bomb. A small amount of fluorine is necessary to prevent tooth decay and the addition of small amounts of calcium fluoride or sodium silico fluoride is now advocated by medical authorities.

In January, 1945, Grand Rapids, Michigan, became the first city in the world to try fluoridation. This program has brought an average reduction of 60% in tooth decay among children up to 16 years of age at an annual cost of 5¢ per person, with no noticeable effect on the health of the general population according to Public Health Service.

One of the main objections to the use of fluorine is that the public water supply system is being used to force mass medication on all the people of a governmental unit by a majority, because some of the people think they know what is good for all the people. If this is true, then the same objection could be used against laws requiring that all table salt be iodized.

Just as iodine is necessary to prevent goiter, calcium is required for strong bones, iron is needed to prevent anemia, and traces of many elements are necessary for good health, so is fluorine required for sound teeth.

Transposition of Music

Donald Kiel
Christian High School, Kalamazoo, Michigan

It is good to demonstrate to the high school physics student some of the many examples of the relationship existing between natural phenomena and the mathematical expression of these phenomena.

One excellent example is that of transposing music, using only simple arithmetical operations. The time for this occurs when the physics class is studying music and sound. The class is divided into three groups, depending on the background of the student in music.

To the first group, those who can read music, an assignment is made of transposing a piece of music. This is done by giving them the eight notes in the octave from middle C, and their frequencies, using the physicist's scale, and the frequencies of the last seven notes relative to that of middle C. This is presented as follows:

C	D	E	F	G	A	B	C'
256	288	320	341	384	426	480	512
1	9/8	5/4	4/3	3/2	5/3	15/8	2/1

To this group of students is also given a few bars of the melody of a song written in the key of C. To transpose from the key of C to any other key, the student multiplies the frequency of the given note by the relative frequency of the note which names the key to which he is transposing.

For example, to transpose to the key of D, the student multiplies the frequency of each of the given notes by 9/8.

(C) $256\times 9/8$ gives 288 (D)

(D) $288\times 9/8$ gives 324 (E), since it varies only by 4 vibrations/second

(E) $320\times 9/8$ gives 360 ($F\natural$), since it is about half-way between F and G

(B) $480\times 9/8$ gives 540 ($C\natural$ in the next octave) since 540 is 2×270

This process can be extended to transposing from any key to any other key by finding the relative frequency of the note naming the new key to the note naming the key in which the original music is written.

To the second group of students, those unable to read music easily, but with some background, is assigned the construction of a scale in some other key, given the key of C.

The same procedure is followed, that of multiplying each of the frequencies of the notes in the scale of C by the relative frequency of the note naming the key in which we desire the scale.

To the third group, those with no appreciable background in music,

is assigned the task of constructing a chord, given only a single note. Since three notes are harmonious only when their frequencies are in the ratio of small whole numbers to one another, the student is asked to multiply the frequency of the given note by 5/4 and by 3/2. This would then give three notes whose frequencies are in the ratio 4:5:6. The student is then asked to construct one other chord, using the same single note as the base, but having different ratios.

Most of these projects can be finished within the class period. The class then assembles around a piano where the transposed music is played, the scales are played, and the chords are sounded.

The students, in carrying out these assignments, realize some sense of accomplishment in performing these operations, which usually require technical training in music theory. They also have another opportunity to see the unity in nature and the relationship existing in natural laws. It should also inspire some to a greater interest in music, or at least a better understanding of it. Of course, the main purpose in teaching this operation in the physics class is to give the student an insight into the mathematical relationships inherent in music and harmony.

Demonstration on Standing Waves

An "Easy Does It"

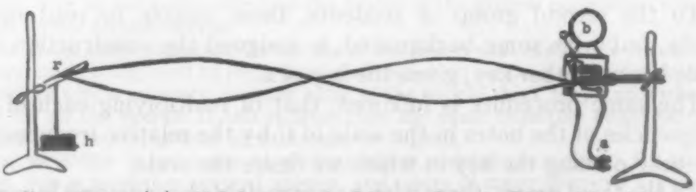
Rebecca E. Andrews

Woodrow Wilson High School, Washington, D. C.

This demonstration to show standing waves uses pieces of apparatus that are customarily found around a physics laboratory.

The method of setting it up is simple. A cord four or five feet long is tied at one end to the armature of a small electric bell and at the other end around a rod to a holder with a weight on it, as shown in the figure. A 4–6 volt source of electricity applied to the bell sets the armature into vibration and this vibration sets the cord into motion. By moving the rod over which the cord hangs back or forth so that the length of the cord is varied or by placing different weights on the hanger so that the tension is varied a different number of loops may be produced on the cord.

The waves can be seen very clearly.



Standing waves: a. 4–6 volt D.C. source; b. Bell; r. Rod; h. Holder with weight

Certification Requirements in Mathematics and Science—A Follow-Up of Recent Changes

David S. Sarner and Jack R. Frymier
Temple University, Philadelphia, Pennsylvania

For the past two years the cry has been for more and more emphasis on the teaching of mathematics and science in the American public schools.

In a previous paper[1] the authors reported that throughout the 48 states, the mean number of semester hours of mathematics needed for certification was 17.9 semester hours of college credit. At the time the basic requirements for mathematics and science teachers appeared to be inadequate.

What have the various states done during the past year to meet the needs of the time?

The writers mailed a copy of their earlier findings to each state department of education and requested a statement concerning any changes already in effect or changes contemplated in their mathematics and science teacher certification requirements. A request was also made for a statement if *no* changes had been made in these requirements or if none were contemplated. A follow-up letter was sent to the state superintendents of those states from which no replies were received. In all, 39 of the 48 states responded.

Only two of the 39 states which replied have made any specific changes. Pennsylvania has increased the requirements in mathematics, biology, physics, and general science from 18 to 24 semester hours. They have also increased the comprehensive science requirement from 18 to 40 semester hours. New York clarified the postgraduate requirements that a teacher could take 6 semester hours of credit in his teaching field instead of six semester hours in education courses if he desired.

Nine other states are in the process of considering, revising, or making recommendation concerning their mathematics and science teacher certification requirements.

Twenty-eight states have made no changes whatsoever, nor are they considering any at the present time.

It was also noted that most of these 11 states which have made or are considering making changes in their certification requirements are states which *already* have fairly strong programs in the certification of mathematics and science teachers.

The authors again ask: Can we get more and better science teachers

[1] Sarner, David S. and Frymier, Jack R. "Certification Requirements in Mathematics and Science," School Science and Mathematics. June, 1959, 456–460.

by having low minimum requirements? Can state legislatures or boards of education justify creating situations wherein prospective teachers spend two or more years in general education and sometimes less than one full semester in teaching field subject matter area preparation? We must find ways to strengthen teacher education programs in mathematics and science.

PROBLEM DEPARTMENT

Conducted by Margaret F. Willerding

San Diego State College, San Diego, Calif.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve her readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, San Diego State College, San Diego, Calif.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2631. 2657. *C. W. Trigg, Los Angeles, Calif.*

2666. *Susie Moore, Waltham, Mass.*

2666. *Jesse Hoagland, Moose Jaw, Canada.*

2666. *Levi P. Bird, Auburn, N. Y.*

2553. ***Proposed by V. C. Harris, San Diego, Calif.***

Which tells more about the behavior of α, β, functions of x:

$$\lim (\alpha-\beta)=0$$

or

$$\lim \alpha/\beta=1?$$

Solution by Howard Grossman, New York, N. Y.

If the limits are of increasing absolute values of α, β, then $\alpha-\beta\to 0$ tells more. If the limits are of decreasing absolute values of α, β, then $\alpha/\beta\to 1$ tells more.

E.G., let $\alpha=x^2+3, \beta=x^2, x\to\infty$. Then $\alpha/\beta\to 1$, but $(\alpha-\beta)\to 3$, not 0. On the other hand, let $\alpha=2x^{-1}, \beta=x^{-1}, x\to\infty$. Then $(\alpha-\beta)\to 0$, but $\alpha/\beta\to 2$, not 1.

2677. *Proposed by C. N. Mills, Sioux Falls College, S.D.*

From a book on Chinese mathematics. Given a quadrant of a circle of radius R. Three equal circles, radius d, are inscribed so that one of them is tangent to the quadrant arc at its midpoint, and is tangent to the other two circles which are tangent to the quadrant radii. Show that the radius of each circle is $R(\sqrt{3}-\sqrt{2})$.

Solution by C. W. Trigg, Los Angeles City College

Possibly the problem suffered in translation, for the combined areas of the three circles would be $3\pi R^2(\sqrt{3}-\sqrt{2})^2 \doteq 0.303\pi R^2$, hence could not be inscribed without overlapping in a quadrant of area $0.25\pi R^2$. Furthermore, additional information is needed in order to locate the place of tangency "to the quadrant radii." From the infinite possibilities, three cases have been selected for discussion—two limiting and one intermediate configurations.

In Figure 1:

$$R=d+d\sqrt{3}+d+d\sqrt{2}=d(2+2+\sqrt{3}).$$
$$d=R/(2+\sqrt{2}+\sqrt{3})=R(2+5\sqrt{2}+3\sqrt{3}-4\sqrt{6})/23\doteq 0.194R.$$

In Figure 2:

$$R=d+3d\sqrt{2}=d(1+3\sqrt{2}).$$
$$d=R/(1+3\sqrt{2})=R(3\sqrt{2}-1)/17\doteq 0.191R.$$

In Figure 3:

$$(2d)^2=2(R-d)^2-2(R-d)(R-d)\sqrt{3}/2.$$
$$4d^2=(2-\sqrt{3})(R-d)^2$$
$$\frac{d}{R-d}=\frac{\sqrt{2-\sqrt{3}}}{2}=\frac{\sqrt{3}-1}{2\sqrt{2}}$$
$$\frac{d}{R}=\frac{\sqrt{3}-1}{2\sqrt{2}+\sqrt{3}-1}=3\sqrt{6}+4\sqrt{3}-5\sqrt{2}-7.$$
$$d\doteq 0.206R.$$

A solution was also submitted by the proposer.

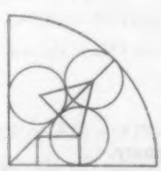


FIG. 1

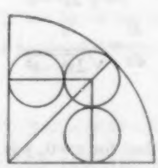


FIG. 2

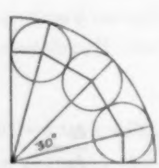


FIG. 3

2678. *Proposed by Brother Fidelis Leo, Pittsburgh, Pa.*

Given a circle of diameter 10 units with its center at the origin. At the point (0, −2) a circle is drawn with diameter 6 units and inscribed in the large circle. At the point (0, 3) another circle is drawn with diameter 4 units. What is the diameter of the largest circle that can be drawn in the first quadrant between the three circles. (Give a solution other than by measuring.)

Solution by C. W. Trigg, Los Angeles City, College

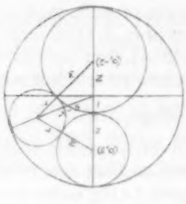


FIG. 1

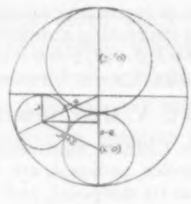


FIG. 2

The radius of the largest circle inscriptible in the first quadrant between the circles can be obtained by equating the longer sides of the two right triangles shown in Figure 1. Thus

$$(2+r)^2-(3-r)^2=(5-r)^2-r^2$$
$$r=1.5.$$

The radius of the largest circle inscriptible between the circles can be obtained by applying Stewart's Theorem to Figure 2. Thus

$$5(5-r)^2=2(2+r)^2+3(3+r)^2-(5)(3)(2)$$
$$76r=120$$
$$r=30/19 \doteq 1.58.$$

Hence, without measuring, it may be concluded that the latter circle does not lie wholly in the first quadrant, and that the circle in Figure 1 does not touch the circle with center at $(0, -2)$. Hence the required diameter of the largest circle is $2(1.5)$ or 3.

2679. *Proposed by Cecil B. Read, University of Wichita, Wichita, Kansas.*

In solving the problem: what point on the hyperbola $x^2-y^2=a^2$ is nearest the origin? a student proceeds as outlined

Let

$$l=\text{distance from origin}$$
$$l=\sqrt{x^2+y^2}$$

substituting the value of y^2 from $x^2-y^2=a^2$

$$l=\sqrt{2x^2-a^2}$$
$$\frac{dl}{dx}=\frac{x}{\sqrt{2x^2-a^2}}$$

Letting

$$\frac{dl}{dx}=0, \qquad x=0 \text{ but for } x=0,\ y \text{ is imaginary.}$$

But the student can obviously see that the points $(\pm a, 0)$ are nearer the origin than any other point. What is wrong?

Solution by the proposer

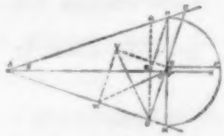
The conditions of the problem restrict us to consideration of the curve $f(x)=\sqrt{2x^2-a^2}$ for $|x|\geq a$. At each endpoints of the interval we have an absolute minimum, without the necessity of $f'(x)$ being zero.

Solutions were also submitted by Bjarne Skaug, Oslo, Norway, W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles, Calif.; and Dale Woods, Pocatello, Idaho.

2680. *Proposed by C. W. Trigg, Los Angeles City College*

A right circular cone is cut in an elliptical section by a plane perpendicular to a given element of the cone at B. Show that the center of curvature of the vertex, B, of the ellipse lies on the axis of the cone.

Solution by the proposer



Method I. Let the plane of the ellipse cut the plane (T) of the element and the axis AX in BE, the major axis of the ellipse. BE intersects the axis in C. Through D, the midpoint of BE, pass a plane perpendicular to AX cutting (T) in MN and the cone in a circle. Then the semi-minor axis of the ellipse is DP, one-half the chord perpendicular to MN at D, so

$$DP^2=(MD)(DN).$$

In (T) draw BQ perpendicular to AX, which then bisects BQ at R. In the triangle BQE, DN is parallel to BQ so

$$DN=BQ/2=BR.$$

From the similar triangles BMD and BCR, we have

$$MD:BD::BC:BR::BC:DN.$$

Therefore

$$BC=(MD)(DN)/(BD)=(DP)^2/(BD),$$

i.e. the square of the semi-minor axis divided by the semi-major axis. Hence C is the center of curvature of the ellipse at B.

We further observe that if in (T) a rectangle $BDVW$ be constructed with $DV=DP$, then the prpendicular to BV from W passes through C. Obviously, the generating angle ϕ of the cone must be less than $\pi/4$.

Method II. Let AB d, then

$$BD=\tfrac{1}{2}d\tan 2\phi.$$

If F is the midpoint of MN, then

$$FD=CD\cos\phi=(BD-BC)\cos\phi=(\tfrac{1}{2}d\tan 2\phi-d\tan\phi)\cos\phi=d\cos\phi\tan^3\phi/(1-\tan^2\phi).$$

$$FN=AF\tan\phi=(AC+CF)\tan\phi=(d\sec\phi+FD\tan\phi)\tan\phi=d\sin\phi/(1-\tan^2\phi).$$

Finally,

$$(DP)^2/(BD)=(FP^2-FD^2)/(BD)=(FN^2-FD^2)/BD=d\tan\phi=BC.$$

Other methods of solution of this problem will be found in the *American Mathematical Monthly* **56**, 339 (May 1949), problem E836.

A solution was also submitted by W. R. Talbot, Jefferson City, Mo.

2681. *Proposed by Brother Felix John, Philadelphia, Pa.*

Solve the system:

$$y^2+yz+z^2=43$$
$$z^2+zx+x^2=109$$
$$x^2+xy+y^2=31$$

Solution by Herbert R. Leifer, Pittsburgh, Pa.

From the second and first equations above

$$x^2+xz-yz-y^2=66$$
$$(x-y)(x+y+z)=66$$

Similarly from the first and third,

$$(z-x)(x+y+z)=12$$

Then

$$(x-y)/(z-x)=66/12,$$

and

$$y=(13x-11z)/2.$$

Substituting in the third equation,

$$199x^2-308xz+121z^2=124.$$

Let $z=mx$, then

$$x^2(199-308m+121m^2)=124$$

and

$$x^2(1+m+m^2)=109,$$
$$(199-308m+121m^2)/(1+m+m^2)=124/109$$

from which it is readily found that $m=7/5,\ 79/67$.

With $m=7/5$, the following values are readily found:

$$x=+5,\quad y=-6,\quad z=+7;\qquad x=-5,\quad y=+6,\quad z=-7.$$

With $m=79/67$, the following values are readily found:

$$x=67\sqrt{3}/21,\quad y=-\sqrt{3}/21,\quad z=79\sqrt{3}/21;$$
$$x=-67\sqrt{3}/21,\quad y=\sqrt{3}/21,\quad z=-79\sqrt{3}/21.$$

Solutions were also submitted by W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles, Calif.; Dale Woods, Pocatello, Idaho; and the proposer.

2682. *Taken from* Mathematical Pie, *Doncaster, England.*

A shopkeeper ordered 19 large and 3 small packets of marbles, all of the same sort. When these arrived at his shop, the box had been handled so roughly that all the packets had come open and the marbles were loose in the box. He counted 224 marbles, so how many should he put into a large packet and into a small packet respectively?

Solution by Dale Woods, Pocatello, Idaho

Let

$x=$ the number of marbles in the large packet

$y=$ the number of marbles in the small packet

$$19x+3y=224$$
$$19x\equiv 224 \bmod 3$$
$$x\equiv 2 \bmod 3$$

Hence the solution $x=11$ and $y=5$

Solutions were also submitted by Robert Guderjohn, Pocatello, Idaho; Margaret Joseph, Milwaukee, Wis.; William Kassen, Fort Wayne, Ind.; J. Byers King, Denton, Md.; H. R. Leifer, Pittsburgh, Pa.; W. R. Talbot, Jefferson city, Mo.; and C. W. Trigg, Los Angeles, Calif.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

For this issue the Honor Roll appears below.

2677, 2679, 2681, 2682. *Lee H. Mitchell, Glencoe, Ill.*

2682. *Richard B. Howell, Stockton, Calif.*

2682. *Howard Thompson and Walter Griffin, Denton, Md.*

2682. *Paul Bjorkholm, Milwaukee, Wis.*

PROBLEMS FOR SOLUTION

2701. *Proposed by C. W. Trigg, Los Angeles, Calif.*

The consecutive odd numbers are grouped as follows: 1, (3, 5); (7, 9, 11); (13, 15, 17, 19); $\cdots$. Find the sum of the numbers of the nth group.

2702. *Proposed by Cecil B. Read, University of Wichita, Wihcita, Kans.*

If the smallest prime factor of a number is greater than the cube root of that number, show that the remaining factor is also prime.

2703. *Proposed by Howard Grossman, New York, N. Y.*

If all the points of the plane are divided into two sets in any way, at least one of the sets must contain the vertices of an equilateral triangle.

2704. *Proposed by Lowell T. Van Tassel, San Diego, Calif.*

Calculate the value or values of

$$\sqrt[i]{i}.$$

2705. *Proposed by Brother Felix John, Philadelphia, Pa.*

Solve the equation:

$$(n^2-5n-24)^{1/2}+(n^2+5n-24)^{1/2}=(n^2+10n+24)^{1/2}-(n^2-10n+24)^{1/2}.$$

2706. *Taken from* Mathematical Pie.

How many different digits are needed by a builder in order to number all of 288 houses in a street? (Front doors only.)

Books and Teaching Aids Received

DOCTOR PARACELSUS, by Sidney Rosen. Cloth. Pages 214. 14×21 cm. 1959. Little, Brown & Company, 34 Beacon St., Boston 6, Massachusetts. Price $3.50.

EXPERIENCE AND NATURE, by John Dewey. Paper. Pages xvi+443. 13.5×20.5 cm. 1958. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.85.

PHILOSOPHY AND THE PHYSICISTS, by L. Susan Stebbing. Paper. Pages xvi+295. 13.5×20.5 cm. 1958. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.65.

FROM EUCLID TO EDDINGTON, by Sir Edmund Whittaker. Paper. Pages ix+212.

13.5×20.5 cm. 1958. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.35.

THE PHILOSOPHY OF SPACE & TIME, by Hans Reichenbach. Paper. Pages xvi+295. 13.5×20 cm. 1958. Dover Publications, Inc., 920 Broadway, New York 10 N. Y. Price $2.00.

AN INTRODUCTION TO STATISTICAL MECHANICS, by J. S. R. Chisholm, *University College, Cardiff* and A. H. de Borde, *The University, Glasgow*. Cloth. Pages ix+160. 13.5×21.5 cm. 1958. Pergamon Press Inc., 122 East 55th Street, New York 22, N. Y. Price $6.00.

FUNDAMENTALS OF ELECTRONICS, by F. H. Mitchell, *University of Alabama*. Cloth. Pages xi+260. 15×23 cm. 1959. Addison-Wesley Publishing Company, Inc., Reading, Massachusetts. Price $6.50.

THE FIFTH MENTAL MEASUREMENTS YEARBOOK, by Oscar Krisen Buros. Cloth. Pages xxvii+1292. 18×25.5 cm. 1959. The Gryphon Press, 220 Montgomery Street, Highland Park, New Jersey. Price $22.50.

EDUCATORS GUIDE TO FREE FILMSTRIPS, by Mary Foley Horkheimer and John W. Diffor, *Visual Education Director, Randolph High School*. Paper. Pages viii+191. 21.5×27 cm. 1959. Educators Progress Service, Randolph, Wisconsin. Price $6.00.

PHOTOTUBES, by Alexander Schure. Paper. Pages vii+88. 13.5×21.5 cm. 1959. John F. Rider Publisher, Inc., 116 West 14th Street, New York 11, N. Y. Price $1.80.

NUMBERS WE NEED, by William A. Brownell and J. Fred Weaver. Paper. Pages 176. 20.5×27.5 cm. 1959. Ginn and Company, Statler Building, Boston, Massachusetts.

AN ASSESSMENT OF THE PROGRAMS, STAFF, AND FACILITIES OF VIRGINIA PUBLIC HIGH SCHOOL SCIENCE DEPARTMENTS, by David D. Redfield and William D. Hedges. Paper. Pages 54. 19.5×27.5 cm. 1959. Division of Educational Research, University of Virginia, Charlottesville, Virginia.

NOMOGRAMS, by C. V. Gregg. Paper. Pages 23. 13×20.5 cm. 1959. Mathematical Pie, Ltd., 97 Chequer Road, Doncaster, England. Price $.20.

BASIC AUDIO, by Norman H. Crowhurst (three volumes). All paper. All 15×23 cm. All 1959. John F. Rider Publisher, Inc., 116 West 14th Street, New York 11, N. Y. Price $2.90 ea.
Vol. I, 114 Pages
Vol. II, 122 Pages
Vol. III, 113 Pages

HIGH SCHOOL MATHEMATICS, Students' Edition, Units 1–4, by University of Illinois Committee on School Mathematics, Max Beberman, Director, Herbert E. Vaughan, Editor. Paper. 20×28 cm. 1959. University of Illinois Press, Urbana, Illinois, Price $2.25.
Unit I, 141 Pages
Unit II, 158 Pages
Unit III, 190 Pages
Unit IV, 131 Pages

HIGH SCHOOL MATHEMATICS, Teachers' Edition, Units 1–4, by University of Illinois Committee on Schoool Mathematics, Max Beberman, Director, Herbert E. Vaughan, Editor. All Paper. All 20×28 cm. All 1959. University of Illinois Press, Urbana, Illinois. Price $6.00.
Unit 1, iv+141 Pages

Unit II, v+158 Pages
Unit III, v+190 Pages
Unit IV, v+131 Pages

The Traveling Elementary School Science Library, by Hilary J. Deason, Nancy C. Barrett, and Stephen W. Fisher. Paper. 47 pages. 14.5×23 cm. 1959. American Association for the Advancement of Science and The National Science Foundation, Washington, D. C. Price $.25.

A Selected List of Career Guidance Publications. Paper. 12 pages. 14.5×23 cm. 1959. American Association for the Advancement of Science, 1515 Massachusetts Ave., N.W., Washington, D. C.

An Inexpensive Science Library, Third Edition by Hilary J. Deason and Robert W. Lynn. Paper. 59 pages. 14.5×23 cm. 1959. American Association for the Advancement of Science and The National Science Foundation, Washington, D. C. Price $.25.

The Traveling High School Science Library, Fifth Edition, by Hilary J. Deason. Paper. 61 pages. 14.5×23 cm. 1959. The American Association for the Advancement of Science and The National Science Foundation, Washington, D. C. Price $.25.

The AAAS Science Book List, by Hilary J. Deason. Paper. 140 pages. 14.5×23 cm. 1959. American Association for the Advancement of Science and The National Science Foundation, Washington, D. C. Price $1.00.

Manual for Outdoor Laboratories: The Development and Use of School-grounds as Outdoor Laboratories for Teaching Science and Conservation, Richard L. Weaver, Editor. Paper. 18×25.5 cm. 81 pages. 1959. Interstate Printers and Publishers, Inc., 19–29 N. Jackson St., Danville, Illinois. Price $1.25.

Laboratory Exercises for Physics, by Harvey E. White. Paper. Pp. vii+184. 17×24 cm. 1959. D. Van Nostrand Co., Inc., Princeton, New Jersey. Price $2.96.

Elementary Teachers Guide to Free Curriculum Materials, Patricia H. Suttles, Editor. Paper. Pp. xiv+313+33. 21×27.5 cm. Educators Progress Service, Randolph, Wisconsin. Price $6.50.

Engineering Enrollments and Degrees 1958, by Justin C. Lewis and Henry H. Armsby. Paper. Pages vii+50. 19.5×26 cm. 1959. United States Government Printing Office, Division of Public Documents, Washington 25, D. C. Price $.40.

Your Science Fair, by Arden F. Welte, James Dimond, Alfred Friedl. Paper. Pages iii+103. 21×27 cm. 1959. Burgess Publishing Company, 426 South 6th Street, Minneapolis 15, Minnesota. Price $2.75.

Trigonometric Novelties, by William R. Ransom, *Emeritus Professor of Mathematics, Tufts University*. Paper. Pages vi+80. 13.5×21.5 cm. 1959. J. Weston Walch, Box 1075, Portland, Maine. Price $1.00.

3 Famous Geometries, by William R. Ransom. Paper. Pages iii+55. 14×21.5 cm. 1959. J. Weston Walch, Box 1075, Portland, Maine. Price $1.00.

A Laboratory Manual for High School Biology, Teachers' Guide, by Thomas H. Knepp. Paper. Pages 127. 20.5×28 cm. 1957. J. Weston Walch, Box 1075, Portland, Maine.

A Laboratory Manual for High School Biology, by Thomas H. Knepp. Paper. 59 Pages. 21×28 cm. 1959. J. Weston Walch, Box 1075, Portland, Maine.

TEACHING ELEMENTARY SCIENCE WITHOUT A SUPERVISOR, by Harold R. Hungerford and Robert E. Drew. Paper. 286 Pages. 20×27.5 cm. 1959. J. Weston Walch, Box 1075, Portland, Maine. Price $3.00.

SUCCESSFUL DEVICES IN TEACHING CHEMISTRY, by Paul Westmeyer. Paper. Pages ii+258. 20×27.5 cm. 1959. J. Weston Walch, Box 1075, Portland, Maine. Price $3.00.

CHEMISTRY CAN BE FUN, by Sister Mary Francesca, M.S.C. Paper. Unpaged. 21×28 cm. 1959. J. Weston Walch, Box 1075, Portland, Maine. Price $2.50.

SIMPLE EXPERIMENTS IN BIOLOGY FOR HOME AND SCHOOL, by Helen W. Boyd. Paper. Pages v+157. 20×27.5 cm. 1959. J. Weston Walch, Box 1075, Portland, Maine. Price $2.50.

MAN AND THE PHYSICAL WORLD, by David E. Newton. Paper. Pages iii+280. 21×28 cm. 1959. J. Weston Walch, Box 1075, Portland, Maine. Price $3.00.

ALBERT EINSTEIN, by Arthur Beckhard. Cloth. 126 Pages. 13×20 cm. 1959. G. P. Putnam's Sons, 210 Madison Avenue, New York, N. Y. Price $2.50.

MOON BASE, by William Nephew and Michael Chester. Cloth. 72 Pages. 15.5×21.5 cm. 1959. G. P. Putnam's Sons, 210 Madison Avenue, New York, N. Y. Price $2.75.

MAGIC, SCIENCE AND INVENTION, by Amabel Williams-Ellis. Cloth. 64 Pages. 12.5×20.5 cm. 1959. G. P. Putnam's Sons, 210 Madison Avenue, New York, N. Y. Price $2.00.

EXPLORING BIOLOGY, by Ella Thea Smith. Cloth. 731 Pages. 15.5×23.5 cm. 1959. Harcourt, Brace and Company, Inc., 750 Third Avenue, New York 17, N. Y. Price $5.20.

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EVERYDAY PROBLEMS IN SCIENCE, by Wilbur L. Beauchamp, John C. Mayfield, Joe Young West. Cloth. 528 pages. 20×23 cm. 1959. Scott, Foresman and Co., Chicago, Ill.

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A NEW ANALYTIC GEOMETRY, by J. E. Durrant and H. R. Kingston. Cloth. x+348 pages. 12.5×18.5 cm. 1941. St. Martin's Press, Inc., 175 5th Ave., New York 10, N. Y. Price $1.90.

THE STRUCTURE AND EVOLUTION OF THE UNIVERSE, by G. J. Whitrow. Paper. 212 pages. 13.5×20.5 cm. 1959. Harper and Brothers, 49 E. 33rd St., New York 16, N. Y. Price $1.45.

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SCIENCE AND HUMAN VALUES, by J. Bronowski. Paper. 94 pages. 13.5×20.5 cm. 1959. Harper and Brothers, 49 E. 33rd St., New York 16, N. Y. Price $.95.

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ANCIENT SCIENCE AND MODERN CIVILIZATION, by George Sarton. Paper. 111 pages. 13.5×20.5 cm. 1959. Harper and Brothers, 49 E. 33rd St., New York 16, N. Y. Price $.95.

ECHOES OF BATS AND MEN, by Donald R. Griffin. Paper. 156 pages. 10.5×18 cm. 1959. Doubleday and Co., 575 Madison Avenue, New York 22, N. Y. Price $.95.

HOW OLD IS THE EARTH? by Patrick M. Hurley. Paper. 160 pages. 10.5×18 cm. 1959. Doubleday and Co., 575 Madison Avenue, New York 22, N. Y. Price $.95.

THE REALM OF THE NEBULAE, by Edwin Hubble. Paper. Pages xiv+207. 13.5×20 cm. 1958. Dover Publications, Inc., 180 Varick Street, New York 14, New York. Price $1.85.

OUT OF THE SKY, An Introduction to Meteoritics, by H. H. Nininger. Paper. Pages viii+336. 13.5×20 cm. 1952. Dover Publications, Inc., 180 Varick Street, New York 14, New York. Price $1.85.

FIND A CAREER IN CONSERVATION, by Jean Smith. Cloth. 160 Pages. 13×20 cm. 1959. G. P. Putnam's Sons, 210 Madison Avenue, New York City, New York. Price $2.75.

ELEMENTS OF REINFORCED CONCRETE, by Sylvan P. Stern. Cloth. Pages xiv +444. 14.5×22.5 cm. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, New York. $7.95.

LET'S GO TO A WEATHER STATION, by Louis Wolfe. Cloth. 47 Pages. 16×20 cm. 1959. G. P. Putnam's Sons, 210 Madison Avenue, New York City, New York. Price $1.95.

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HOW TO BEGIN YOUR FIELD WORK, BOOK ONE: WOODLAND, by V. E. Ford, *Biology Department, Hove County Grammar Schools for Girls*. Paper. 47 Pages. 18.5×24.5 cm. 1959. John Murray, 50 Albermarle Street, London, W. I.

WILD FOLK AT THE SEASHORE, by Carroll Lane Fenton. Cloth. 128 Pages. 16×21.5 cm. 1959. The John Day Company, Inc., 210 Madison Ave., New York, N. Y. Price $3.50.

ELEMENTS OF CALCULUS AND ANALYTIC GEOMETRY, by George B. Thomas, Jr., *Massachusetts Institute of Technology*. Cloth. Pages x+580. 15×23 cm. 1959. Addison-Wesley Publishing Company, Inc., Reading, Massachusetts. Price $7.50.

AUTOMATION CYBERNETICS AND SOCIETY, by F. H. George. Cloth. 283 Pages. 13.5×22 cm. 1959. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $12.00.

STATISTICS OF STATE SCHOOL SYSTEMS: 1955–56, Chapter 2, by Samuel Schloss and Carol Joy Hobson. Paper. Pages xi+140. 15×23 cm. 1959. U. S. Department of Health, Education, and Welfare, Washington, D. C. Price $.45.

ATTITUDES OF CERTAIN HIGH SCHOOL SENIORS TOWARD SCIENCE AND SCIENTIFIC CAREERS, by Hugh Allen, Jr. Paper. Paper. Pages x+53. 13.5×21 cm. 1959. Bureau of Publications, Teachers College, Columbia University, New York 27, N. Y. Price $1.25.

THE CANTERBURY PUZZLES, by H. E. Dudeney. Paper. 255 Pages. 13.5×20.5 cm. 1958. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.25.

AMUSEMENTS IN MATHEMATICS, by H. E. Dudeney. Paper. Pages vii+258. 1958. 13.5×20.5 cm. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.25.

MATHEMATICAL PUZZLES OF SAM LOYD, Selected and Edited by Martin Gardner. Paper. Pages xv+167. 13.5×20.5 cm. 1959. Dover Publications, Inc., 180 Varick Street, New York 14, N. Y. Price $1.00.

SAM COLT AND HIS GUN, by Gertrude Hecker Winders. Cloth. 159 Pages. 13.5×20.5 cm. 1959. The John Day Company, 62 West 45th Street, New York 36, N. Y. Price $3.00.

THE MATH ENTERTAINER, by Philip Heafford, *University of Oxford*. Cloth. 176 Pages. 12.5×18.5 cm. 1959. Emerson Books, Inc., 251 West 19th Street, New York, N. Y. Price $2.95.

BASIC MATHEMATICS FOR HIGH SCHOOLS, by T. W. Thordarson and R. Perry Anderson. Cloth. Pages vii+310. 14.5×23 cm. 1959. Allyn and Bacon, Inc., Boston, Mass.

HIGH SCHOOL CURRICULUM ORGANIZATION PATTERNS AND GRADUATION REQUIREMENTS IN FIFTY LARGE CITIES, by Grace S. Wright. Paper. 27 Pages. 20×26 cm. 1959. U. S. Department of Health, Education, and Welfare, Washington, D. C.

TEACHER SUPPLY AND DEMAND IN UNIVERSITIES, COLLEGES, AND JUNIOR COLLEGES, 1957–58 AND 1958–59. Paper. 86 Pages. 21.5×28 cm. 1959. Research Division, National Education Association of the United States, 1202 Sixteenth Street, N.W., Washington 6, D. C. Price $.50.

A CONCRETE APPROACH TO ABSTRACT ALGEBRA, by W. W. Sawyer. Paper. 233 Pages. 10.5×18 cm. 1959. W. H. Freeman and Company, 660 Market St., San Francisco 4, California. Price $1.25.

A BRIEF TEXT IN ASTRONOMY, by William T. Skilling, *San Diego State College*, and Robert S. Richardson, *Mount Wilson and Palomar Observatories*. Cloth. Pages x+353. 16×23.5 cm. 1954, 1959. Henry Holt and Company, Inc., 383 Madison Avenue, New York 17, N. Y. Price $6.00.

Book Reviews

THE EARTH AND ITS RESOURCES, Third Edition, by Vernor C. Finch, Glenn T. Trewartha, and M. H. Shearer. Cloth. Pp. vi+584. 16×23.7 cm. 1959. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $6.00.

The introductory chapter of the new third edition of *The Earth and Its Resources* in physical geography and earth science calls attention to some of the recent scientific developments of our space age such as the launching of the first man-made satellites and rockets; and some of the important new information gained during the International Geophysical Year. This high school text in earth science has been a leader in keeping pace with the presentation of new materials in all phases of the subject, including meteorology, geological information, and the economic and geographical relationships of our use of natural resources.

The authors point out in the preface that the purpose of the book is "to present the basic facts concerning the earth as the home of man so that the student may realize their importance and understand their relationship to the problems of his own time and place." Therefore, the major features of the physical earth are presented as (1) the atmosphere—weather and climate; (2) landforms—plains,

plateaus, hill country and mountains; (3) the oceans and their shores; (4) earth resources—waters, vegetation, animal life, soils and minerals.

The text presents in clear and understandable language the facts needed by the beginning student to intelligently appraise current national problems relating to our use of the physical environment and its natural resources.

The conservation of water, vegetation, animal life, soil and minerals are adequately emphasized in keeping with the increased concern these natural resources have been given recently in our nation. In the final chapter the authors show the kinds of natural resources found in different geographical regions of the United States. This emphasizes the wide variety of resources and how each contributes to the economic wealth of our nation. This is particularly important to a fuller understanding of conservation problems that develop in different parts of our country.

The book should serve as an effective teaching guide for classes in geography and conservation. Each chapter concludes with a brief summary, questions for discussion, suggested activities, and topics for class reports. The references have been brought up-to-date with good lists of current selected readings.

The appendix includes valuable information on (1) the seasons, (2) meteorological instruments and the weather map, (3) earth history, (4) learning to use maps, (5) interpretation of maps, (6) U. S. topographic quadrangles, (7) rocks and minerals, (8) useful data and tables. A good selection of physical-political maps in color are a valuable addition to the appendix.

The book, together with a laboratory manual which is available to accompany the text, should serve as an interesting and effective course to present man's most recent accomplishments in his attempt to live with the physical environment of the earth.

Howard H. Michaud
Purdue University
Lafayette, Indiana

Organic Chemistry, Second Edition, by Melvin J. Astle and J. Reid Shelton, both *Professors of Organic Chemistry at Case Institute of Technlogy, Cleveland, Ohio.* Cloth, pages x+771, 19.5×15 cm. 1959. Harper & Brothers, 29 East 33D Street, New York 16, N. Y. Price $7.50.

This is a revision of a textbook that is already well known by teachers of elementary organic chemistry. According to the publishing house statement, "the scope and objectives of the second edition remain the same as for the first, namely: to combine a sound, modern and thorough theoretical discussion of organic structure and reactions with a presentation of the applications of organic chemistry in industry and everyday life."

We are further told that many of the chapters dealing with fundamental chemistry have been completely rewritten in order to bring together a more modern theoretical treatment of structure and reaction mechanisms. Wide use is made of the orbital concept of atomic and molecular structure in order to explain certain properties. The book has the traditional organization in that aliphatic chemistry and aromatic chemistry are each treated separately. The last four chapters deal with some of the more advanced topics:

Chapters 31. Alkaloids
32. Terpenes
33. Steroids
34. High Polymers

Many elementary organic texts do not treat these four subjects so completely.

The publishers have used a good grade of paper, the print is easily read, and the book is well bound and illustrated. A limited number of review exercises are found at the end of each chapter. At the close of the text is found a good list of "References for Supplementary Reading."

The book is intended for use in a full-year course of organic chemistry and

this reviewer feels that a most desirable course in the first year organic chemistry could be planned with this textbook as its basis.

The average class would not be able to digest all of the material included in a two-semester course. This gives the instructor an opportunity to choose.

GERALD OSBORN
Western Michigan University
Kalamazoo, Michigan

MATHEMATICS DICTIONARY, STUDENT'S EDITION edited by Glenn James and Robert C. James. Contributors: Armen A. Alchian, *University of California at Los Angeles;* Edwin F. Beckenbach, *University of California at Los Angeles;* Clifford Bell, *University of California at Los Angeles;* Homer C. Craig, *University of Texas;* Glenn James, *Editor of* Mathematics Magazine; Rogert C. James, *Harvey Mudd College;* Aristotle D. Michal, *formerly of California Institute of Technology;* Ivan S. Sokolnikoff, *University of California at Los Angeles.* Cloth. 474. 15×23 cm. 1959. D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, New Jersey. Price $10.00.

This is what is termed the "Students Edition." Earlier editions have been reviewed in SCHOOL SCIENCE AND MATHEMATICS (Volume 43, page 694, October 1943; Volume 50, pages 247–248, March 1950). Some of the comments which were made in the review published in March 1950 seem still valid: there are certain omissions which many teachers would like to have included [examples mentioned at that time still undefined are Vortex, flat point, zero matrix, cogredient; the terms generating function and ring which were undefined in an earlier edition are now covered]. No doubt any teacher could find certain terms which he wished were included but there is nothing available that even approaches this dictionary in completeness. This reviewer still raises the same objections at some point that were present in 1950: the definition of *central conics* apparently excludes circles and intersecting lines; the definition of *mode* excludes the possibility of a bimodal distribution; one wonders how it is determined that in the number 230 the zero is a significant digit. Possibly the reviewer is quibbling over what are a few minor items. Nevertheless one wonders if the editors of a book ever take the time to read reviewes before proceeding to write a new edition.

It would seem that this work is certainly a valuable addition to any library, private or school. The criticisms are perhaps somewhat minor in nature but the reviewer cannot help but feel that in some cases a more carefuly editing might have produced a better revision.

CECIL B. READ
University of Wichita
Wichita, Kansas

HISTORY OF MATHEMATICS, by David Eugene Smith. Paper. Vol. I, pp. xxii +596; Vol. II, pp. xii+724. 13.5×20 cm. 1923 [Republished 1958]. Dover Publications, Inc., 920 Broadway, New York 10, New York. Price $5.00.

It is refreshing to find again available this classic reference work in the history of mathematics. No doubt most readers are familiar with the work. For the information of those who may not have found it available, the first volume is a general survey of the history of elementary mathematics taking it largely in a chronological order while the second volume treats the subject from a topical point of view. Each volume supplements the other. There has been no attempt in this republication to make any changes or corrections from the last edition. The work is of unquestioned value and at the price at which it is now available it is indeed difficult to see how any high school library could afford not to have the publication on its shelves, to say nothing of the value for the individual teacher

CECIL B. READ

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